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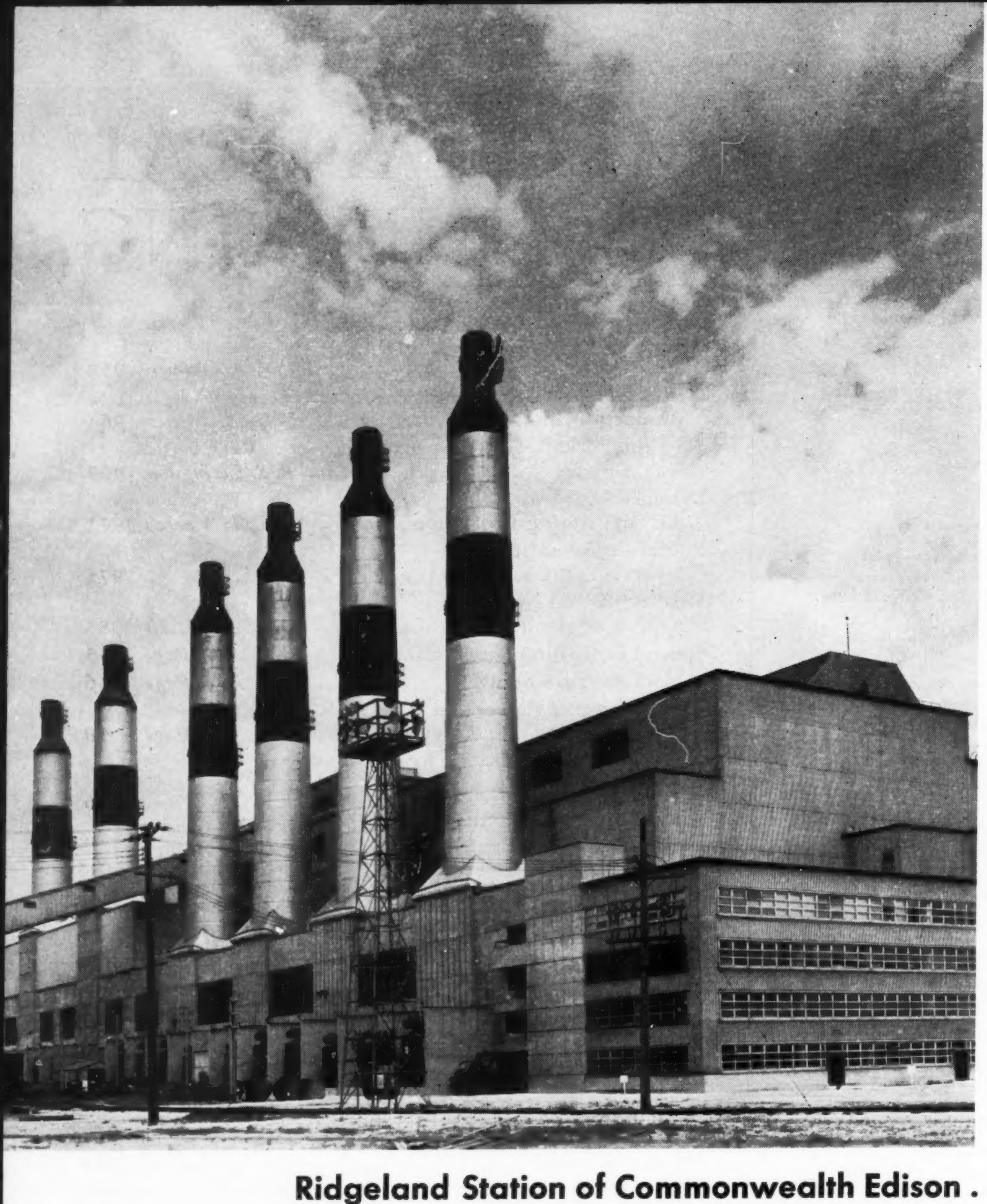
MECHANICAL ENGINEERING



Ridgeland Station of Commonwealth Edison . . .

. . . to be visited during the ASME Diamond Jubilee Annual Meeting in Chicago, Ill., November 13 to 18, 1955. The station has a net generating capacity of 640,000 kw. As a side light to ASME's 75th Anniversary celebration, the Chicago Exposition of Power and Mechanical Engineering will be held in the Coliseum, November 14 to 18. A special insert in this issue of MECHANICAL ENGINEERING gives some details on high-light exhibits at the exposition.

Editorial

MECHANICAL ENGINEERING

November, 1955, Vol. 77, No. 11 ◆ George A. Stetson, *Editor*

Only Himself to Blame

WHERE this is written summer is officially over; but life outside appears to be at its most abundant peak. Wherever there is soil and moisture, vegetation is in its prime, fulfilling the promise of spring in the endless cycle of the seasons. The trees are in full leaf and green, except for a few that have already burst into flame or have captured so much from the sun that they seem to have taken on the golden color of its rays. Day after day the roses unfold as though there were not enough time for each bush to produce its full quota of beauty and fragrance. Vines have all but hidden the old well house and the wisteria has put forth long slender tendrils which grope for a place to cling to and find nothing but others of their kind with which they intertwine for mutual support. The turf is thick and green, and the hedges grow faster than they can be kept in trim. Even the beds of small streams are lined with green; the swamps and ponds teem with life; fields and roadsides are filled with goldenrod, asters, and brilliant sumac. Along the shore the wild roses sprawl over the sand, the feathery tops of the tall grass are higher than a man's head, and the honeysuckle strangles everything within its reach. Surely this is nature in her most fruitful and ample mood.

Soon the dew which forms in the clear still night will turn to frost and the roof of the old barn will glisten in the rising sun. Whisps of vapor will blanket the river and the cove. A few misshapen roses will struggle to unfold, but most of the buds will blacken and droop. Only the chrysanthemums, now in bud against the house, will bring color to the garden. Day and night, slowly at first and then with increasing haste as wind or rain may compel them, the maple leaves will fall to the ground, there to carry on their final functions in the economy of nature, protecting life which still lies hidden in the earth and returning to the soil some of the elements which gave them being. There is no revolt against the rigid discipline of nature.

Then the trees which top the house will spread barren branches against the sky. When the wind is in the east, the noise of the surf will be borne inland, sounding like the agitated murmur of foliage in summer. The first flakes of snow will hiss against the withered leaves cowering on the ground until a thickening blanket deadens the sound of it, and winter comes. Only the tall dark spruce will look as it did months ago, and the ancient lilac, with hollow and twisted trunk, will bear on its leafless branches plump buds of next year's growth, mute evidence that life will return.

Three centuries ago the farmlands ran down to the sea, and those who tilled them and worked the fishing boats lived in crude log houses. They won their living from a wild unfriendly land and were precariously near to destitution if crops should fail. A musket was always at hand if they were in the fields and by the bed at night. Not infrequently might they return to find their houses burned and their families dead or carried away. Surely the curse of Adam lay on them, for they ate bread in the sweat of their faces, yet in the midst of these rigors they dedicated their harvests to Thanksgiving. Today the Indian trail is a paved road patrolled by police in automobiles. Lawns, gardens, and homes fill the fields. The sea yields recreation rather than a livelihood. Electric lights have supplanted candles, stoves and central heating the fireplaces, and families live in peace and plenty, with schools, churches, businesses that provide jobs, an abundance of food and house furnishings, communication with all the world, and rapid transit over land and sea and through the air.

Generation after generation of trees will burst into leaf and shed their foliage just as they have done for thousands of years, content to fulfill the destiny which the harsh economy of nature forces on them. But every generation of man does more than this. He betters his lot, he stores his knowledge, he produces more than he expends, he becomes ever more close to the control of his natural environment, he nourishes and replenishes his spiritual resources, he improves the communities in which he lives, he submits himself to the discipline of his own laws as well as those of nature, he banishes or ameliorates the tragic ravages of disease, he develops a culture, he enjoys regenerating leisure.

What has all this to do with engineering? Simply this, that through engineering, in a society of free men and free institutions, men surge forward toward goals that increase physical, mental, and spiritual well-being. The process, which has been going on ever since man came on this earth, can only keep on going by the continuous exercise of discipline and hard work. Man has only himself to blame if he cannot extend the benefits he has won to all persons in this country and throughout the world. To a much greater extent than with trees, man can give purpose, direction, and acceleration to his own evolution. The future is in his hands, and with it the reasons for his Thanksgiving.

AUTOMATION—

Its Development in Metalworking

- **How did it start?**
- **What does it mean?**
- **Where will it go?**

By Anderson Ashburn

Special Projects Editor
American Machinist
New York, N. Y. Mem. ASME

By "automation," do we mean a word that has recently caught the popular fancy, or do we look beyond the word to mean the automatic handling of work in process, or do we look beyond the handling and refer to the automatic control of work in process? Or do we mean, as some have claimed, something beyond all this—a "second industrial revolution?"

A broad look at these developments over a period of years indicates that this is not a second industrial revolution, not a revolution at all, but a logical step in the evolving science of production methods. In this country we made our major shift from an agricultural to an industrial economy during the latter half of the past century.

The roots of this industry go much farther back, of course. Those who have visited Thomas Jefferson's home at Monticello are likely to conclude that here lived the father of automation. Certainly Jefferson delighted in gadgetry to convey wine from cellar to dining table, to open doors, to tell him the direction of the wind, and to perform other chores.

But the first genius of automation seems to have been Oliver Evans who in the 1780's designed a grist mill in Philadelphia, Fig. 1, containing an ingenious combination of belt conveyers, screw conveyers, and endless-chain buckets that took the grain automatically through cleaning, grinding, and bolting. The mill was automatic from the point at which the grain was unloaded from a wagon into the first hopper until the flour dropped through a chute into a barrel (1).[1] This seems to be the first example of an automatic manufacturing process. The only thing Evans lacked was the word automation. There is some dispute as to whether Evans built a mill incorporating all of his patented devices. But we do know that Thomas Ellicott built one a few years later in Virginia (2).

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Materials Handling Division and presented at a joint session of the Materials Handling and Production Engineering Divisions during the Diamond Jubilee Semi-Annual Meeting, Boston, Mass., June 19–23, 1955, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 55—SA-62.

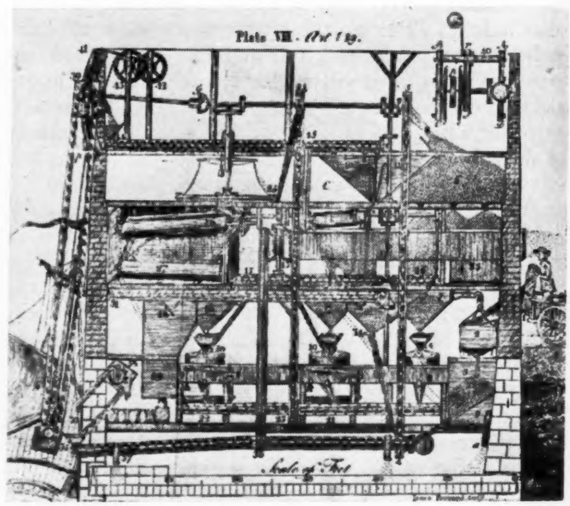


Fig. 1 Oliver Evans' grist mill, designed in the 1780's

And a quarter century later a Russian traveler, Paul Svinin, was writing home, with some exaggeration, that everything in America was done with some special sort of machinery, even sawing rocks, cobbling shoes, making bricks, and forging nails (3).

In England, Bentham and Brunel applied interchangeability, more or less unintentionally, in mechanizing the manufacture of pulley blocks. Bentham secured patents in 1791 and 1793, and Brunel had a working model of his special mortising and boring machines by 1801, Fig. 2. By 1808 their plant was producing 130,000 blocks per year, and continued operation for many years until the iron block outmoded the wooden design (4).

The "American System" of interchangeability was first proposed by Eli Whitney in 1812. We now know the French had attempted it in 1717 and 1785, the second attempt having been reported by Jefferson (5).

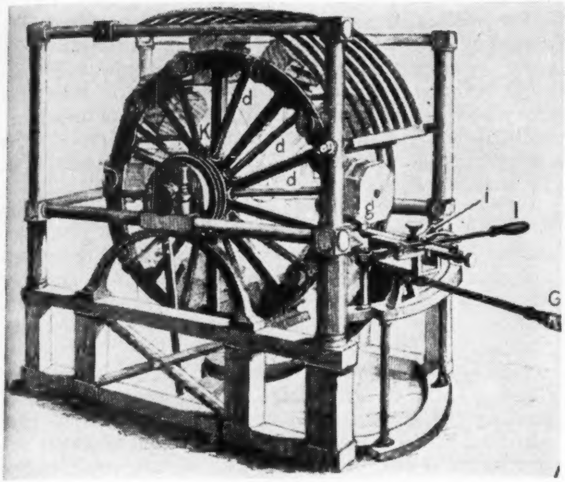


Fig. 2 Brunel's working model block shaping machine, 1801

But it was in the latter half of that century that we began to get really industrial. Civil and mining engineers had to make room for mechanical engineers. In the year 1880, when The American Society of Mechanical Engineers was founded, there were 10,000 patents granted for laborsaving machines. That was the year we achieved our first high-speed steel, though it was another 20 years before the familiar and basic 18–4–1 composition was to be developed.

Automaticity Gains Acceptance

Since then we have seen a steady spread of the automatic approach. We have but to look around to see that there is a high degree of automation in the reduction of ore, the refining of oil, the production of chemicals, the processing of food, the making of cigarettes—in fact, in almost every form of manufacturing except metalworking.

Metalworking history since 1880 has been in part the development of machines that take very little brawn, that make the operator far safer at work than he is at home, and that take considerably less skill to operate. Thus by World War II it was possible to increase the volume of metalworking production about six times from the 1938 prewar level to the 1943 peak (6) because we could train a machine operator in a few hours for many jobs.

Standards Required. But this was only part of the history. We had to develop standards for fits, threads, tapers, for a thousand elements of both machine and product design. Too much credit could hardly be given to ASME for the part it played in this necessary development.

We had to develop machines with more power, and the generator and electric motor made this possible. We had to improve machine rigidity and find tools that would hold size longer. Better tool steels, then carbides, came to our rescue there.

We had to develop a more accurate standard of measurement than the micrometer. The master gage block came to the rescue with a reliable standard. Then faster and more-accurate measuring systems brought fixed-limit gages, optical, air, and electronic equipment into play.

Assembly Line Is Born. A shop that made a lot of a product used to be operated on a process basis. A batch of parts would go to one spot for turning, then to another department for drilling, then across town to be hardened, then back to a third department for grinding. When we had all the parts made, we'd take them across the street and put them together—coming back to fix any that wouldn't fit.

A basic change in this approach took place in 1913 when Henry Ford, presumably reasoning that if meat packers could take a pig apart on a chain conveyer, he could put a car together on an assembly line, made his famous innovation at Highland Park, Mich., attaining a production rate of 10,000 cars a year. When detailed news of this was given by Colvin in a series of 16 articles in 1913 and 1914, the first reaction was one of frank disbelief. A British paper commented, "No manufacturer can possibly build that many cars in one year; and even if he could, he wouldn't be able to sell half of them." But the documentation was convincing and the assembly line spread rapidly, became the basis of our system of mass production (7).

But it is a mistake to think of this as automation, though it was an essential step in that direction. For the assembly line led naturally to the product approach, not just for assembly but for all the preliminary operations. As machines became more specialized, it was possible to make them increasingly automatic in operation.

The Early Transfer Machine. Next came the combining of two or more operations on a single machine bed. It is hard to identify just when this first happened, but the first true transfer machine appears to have been the one built at the Morris automobile plant in Coventry,

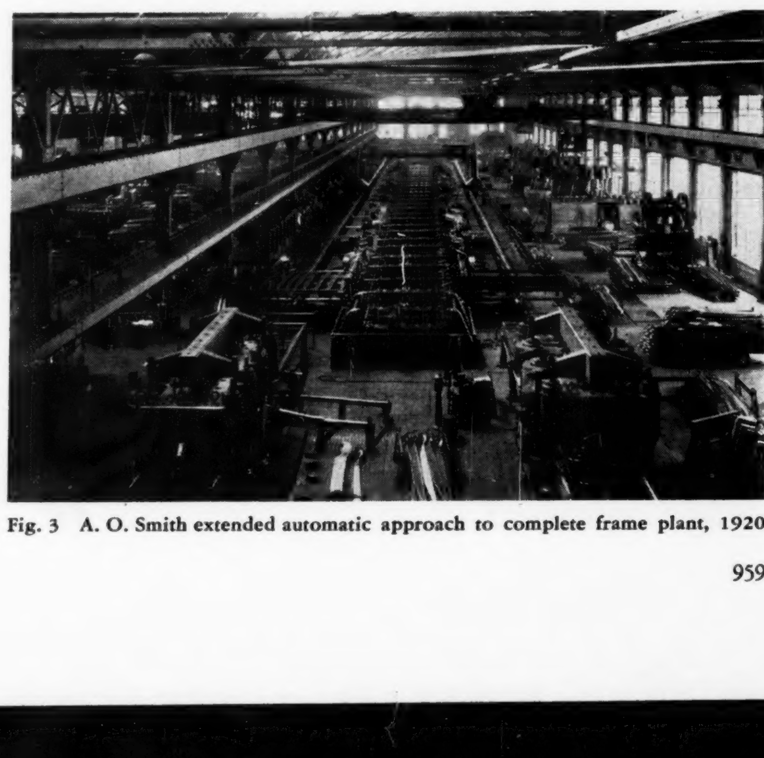


Fig. 3 A. O. Smith extended automatic approach to complete frame plant, 1920

England, in 1924. This machine was 181 ft long, 11 ft 4 in. high, and 11 ft wide. It weighed more than 300 tons and produced finished cylinder blocks from rough castings, removing about 40 lb of metal. There were 53 operation stages and 81 electric motors with a combined rating of 267 hp. It was actually a collection of standard machines attached to a continuous bed with a continuous table mounting the fixtures and jigs and a common control shaft to time the motion of all the heads. Cycle time on the machine was 4 min, with duplex lines handling blocks alternately for boring and other operations requiring more than 4 min" (8).

A few years later, in 1929, Graham-Paige Motors installed a system for operations in their cylinder department which included automatic jigs and fixtures with transfer bars to move work from machine to machine in which all the basic elements of a modern transfer machine were present (9).

Now we begin to see instances of all these developments being tied together efficiently into the automatic production of a metal component. A. O. Smith did it first in 1920 (10) with auto frames, Fig. 3, and somewhat later Budd Wheel did it with car wheels. There were many such isolated cases over the years, but we are handicapped in tracking them down because they were considered to be so specialized as to be of little interest to others. Automation had not yet emerged as a principle, though it certainly existed as a fact.

What Is Automation?

Let us pause to take a look at this suddenly popular, often misunderstood word automation. The word itself is now the simplest thing in the whole complex picture, for the lexicographers have already traced the history of it, and written a definition for it.

The word was coined by D. S. Harder of Ford Motor Company, in 1947. Someone had asked for means of handling parts in process without the delays caused by the human element. "What we need," said Harder, "is more automation." It is possible that other people had coined the same word before, but this time it stuck. The name was applied to a special task force at Ford assigned to mechanize the loading and unloading of new equipment. The initial emphasis was on presses. The "iron hand" to feed presses had already been developed at Fisher Body, and this and other devices were adapted to a whole series of press operations.

The word automation first appeared in print in *American Machinist* for October 21, 1948. LeGrand (11) at that time defined it as "... the art of applying mechanical devices to manipulate workpieces into and out of equipment, turn parts between operations, remove scrap, and to perform these tasks in timed sequence with the production equipment so that the line can be wholly or partially under pushbutton control at strategic stations."

The editors of Merriam-Webster's International Dictionary plan now to define the word in their next edition thus: "automation, n. 1 The act or technique of making a manufacturing process fully automatic. By this technique parts are moved into and out of machines without being handled by human operators. 2 The state of being automatic. 3 Automatic operation, as of a machine" (12).

Harder has since said (13) that automation is more than this, that it is "a philosophy of manufacturing" and the original definition must be broadened to include design of parts, methods for their manufacture, and production-tool control systems. Alspach has defined automation simply and concisely as "continuous automatic production."

High-Speed Machining. Credit also should be given to the development of high-speed machining for the impetus it has given to automation. At about the time that Ford first was working on the automation of presses, and before it had been applied to metal-cutting operations, several hardy souls in widely scattered shops began to experiment with cutting speeds much higher than

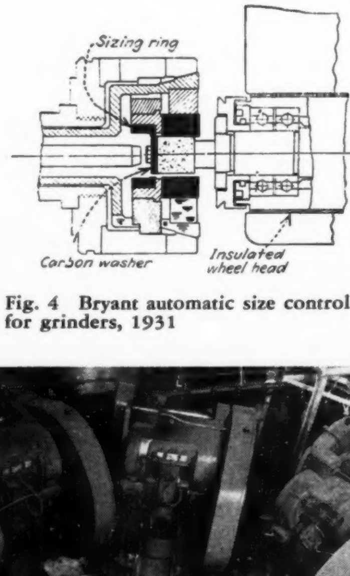


Fig. 4 Bryant automatic size control for grinders, 1931

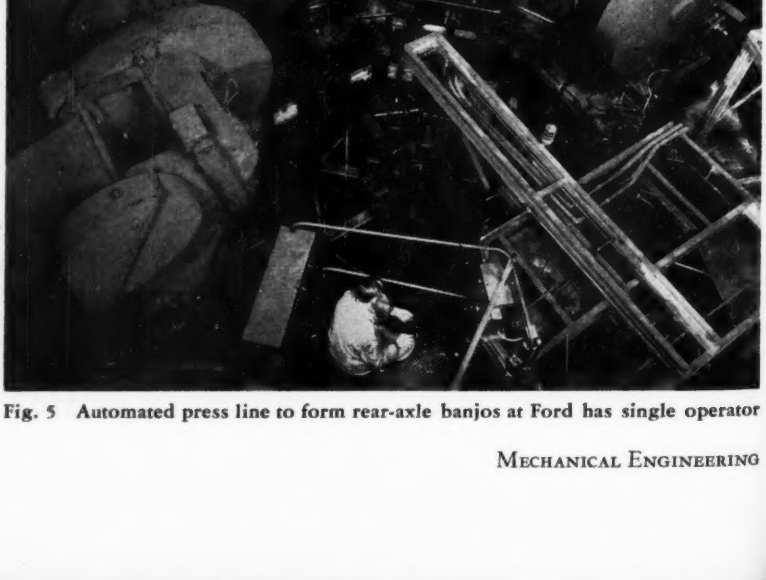


Fig. 5 Automated press line to form rear-axle banjos at Ford has single operator

those conventionally recommended. Drawing on these experiences, and the work of researchers here and abroad, Tangerman wrote a series of articles (14) in 1948, 1949, and 1950 that started a controversy of considerable proportions, that made "high-speed machining" a popular term, that stimulated several research projects leading to the concept of optimum machining rates, and that appears to have caused a rather common shift to speeds well above the accepted handbook values when tools and equipment permit. It followed naturally that the shorter machining times made the same old loading times rather ridiculous and pushed the development of automation to redress the balance.

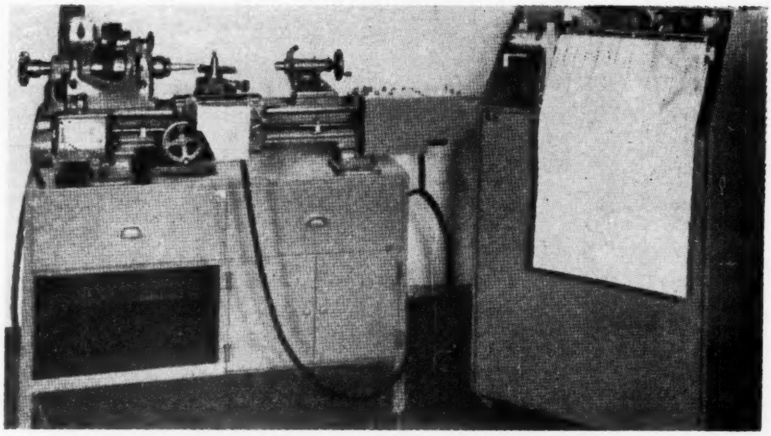


Fig. 6 An early example of the Arma punched-tape control system for lathe, 1948

Automatic Machine Control. To find the origin of automatic machine control, we have to go back to 1801 and the Frenchman, Joseph Marie Jacquard, and his pattern loom controlled by punched-cards linked together in a chain. The Jacquard loom is still used today, in countless variations, to produce rugs, tapestries, lace, and embroidery.

Punched tape found many other applications. Most of you can remember the player piano. In 1887 Tolbert Lanston invented the monotype, first produced in 1897, in which a punched tape governs the casting and assembly of the type.

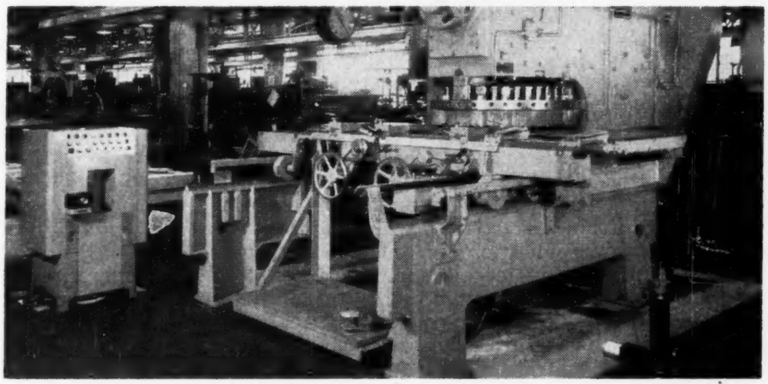


Fig. 7 Punched-card digital control through syntrons for turret punch, 1954

Automatic control first came to the metalworking machine, however, with the cam. Perhaps the key was the turret lathe, developed in 1854, and transformed into an automatic machine in 1876 by Christopher M. Spencer (15). The importance of the blank cam cylinder with flat strips adjustable for different jobs was overlooked by his patent attorney. Thus he secured no rights on the device that made automatic bar and chucking machines possible, and is still used today. The automatic screw machine was developed at Brown & Sharpe during the Civil War; the multiple-spindle automatic at White Sewing Machine in Cleveland.

These developments were paralleled by the development of contouring machines with tracer control working first mechanically, then electrically, and hydraulically.

Automatic Size Control. An early example of automatic size control was developed by Bryant (16) in 1931. Contact between a carbon washer, Fig. 4, adjacent to the wheel and a carbon sizing ring mounted in the chuck backed off the feed when the desired size had been reached.

Typical of one large area of automation is the combining of operations into a single machine. Another area is to combine machines into a line, Fig. 5. Here a circle of five punch presses forms rear-axle banjos. Presses are fed by the rotating spider. One man operates the entire rig and the hazard associated with many press operations is virtually eliminated (17).

Tape Controls. Most of the effort to add flexibility to automation is toward tape or some form of numerical control. An early example was the Arma lathe, Fig 6, developed on the player-piano system about 1948 (18). Then Cunningham (19) produced noncircular gears commercially on a shaper controlled by film.

Recently tape developments have come so fast it is difficult to record them all. We have had the magnetic-tape record-playback control in which the control records machine movements while the operator makes one part, then playback of the tape duplicates the motions (20).

A basically different approach is the positioning device, Fig. 7, in which the table of a turret punch press is located and the turret is rotated from punched instructions on cards by a digital computer that translates coordinates and diameter into instructions for a Selsyn system (21). An earlier system employed a computer to count scribed lines on engraved control bars (22).

A similar application is in the positioning of a riveting machine by punched film. The same approach has also been applied to press brakes (23). The aim of all these is to free automation from the tyranny of the need for high volume with fixed design.

There is, finally, the experimental setup at the Massa-

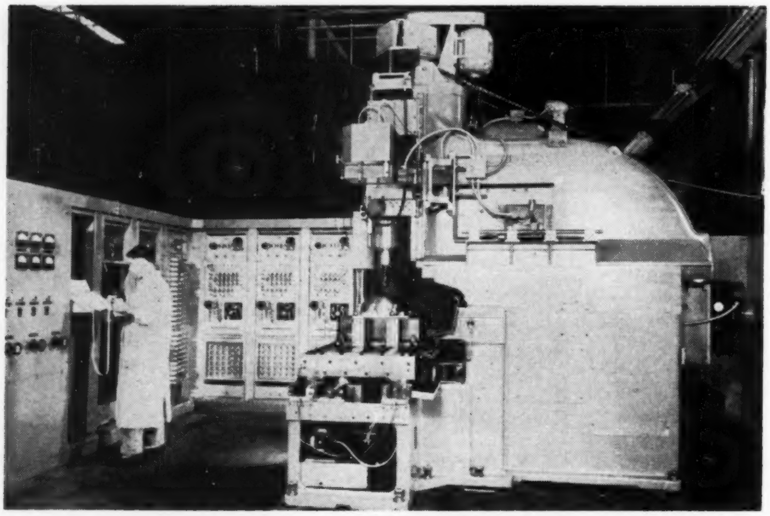


Fig. 8 Numerical control system for milling machine, developed at M.I.T. 1954

chusetts Institute of Technology, where a milling machine, Fig. 8, is under complete control through servomechanisms of a digital to analog computer receiving its instructions from punched tape. This machine, not in itself compact or economical enough for the average plant, is producing valuable research data which point the way for commercial application of numerical control working. Already this machine, in special cases, has proved an economical production tool. A complete description of this work has been prepared by Stocker and Emerson (24). As a result of this stimulus, several compact commercial control units have been announced by machine-tool builders this year.

Keeping Tools Sharp

We have the automated production setup, and the means for making it flexible where necessary. There remains a major problem: the dull tool. With grinders, the automatic dressing attachment and various pneumatic and electrical gaging devices provided the solution some time ago. The solution of the problem for cutting tools is more recent.

Tool-Control Board. One approach is the tool-control board, Fig. 9. A spare set of tools is preset in holders. Tests show the safe number of parts each tool can produce. The control board counts for each tool and stops

Fig. 9 Cross tool control board for transfer machine shows, by tests, the safe number of parts each tool can produce

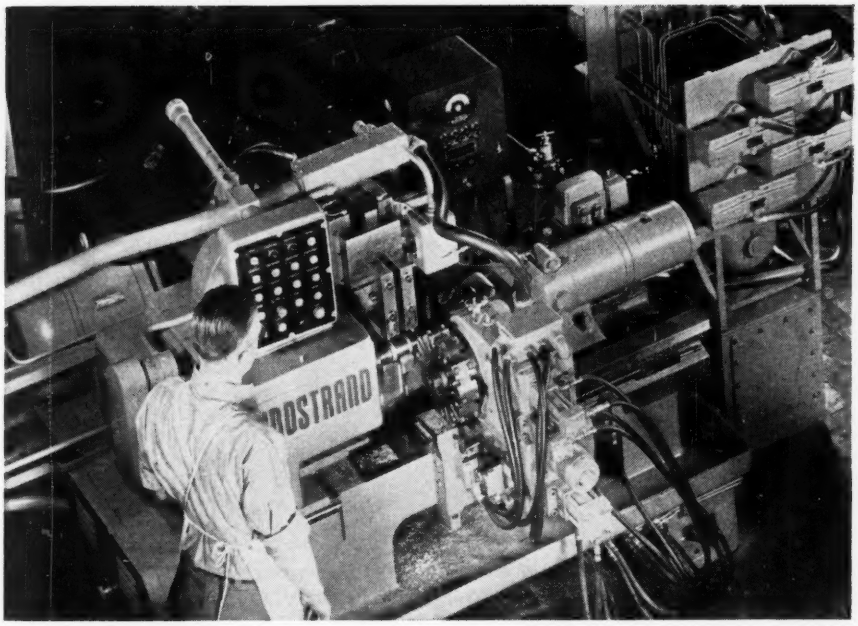


Fig. 10 Sundstrand self-resetting automatic lathe, 1955; 10 sets of tools are preset in holders and rotate into position in turn

the machine when one of the tools reaches its limit. The control lights indicate the tool to be replaced and the operator can replace it with the preset equivalent rather quickly.

Next step obviously is to have a toolholder that resets the tool automatically as it wears and replaces it when regrinding is needed. Several machines that accomplish this have been under development recently and the first ones are just now going into production in metalworking plants.

In the self-resetting lathe, Fig. 10, air-gaging of the part controls the form tools. One set of tools is advanced six times, 0.0005 in. each time to compensate for tool wear; then the turret rotates to bring a fresh preset pair of tools into position. After ten turret positions, the machine stops for installation of a new tool turret.

Assembly Machines. We are hearing a good deal about assembly now. The electrical manufacturers have assembly machines. Other metalworking industries have, or are developing, them. An assembly machine can be a very complicated looking device, but in fact is likely to be a large collection of individually simple mechanical movements with pneumatic or electronic checking devices in a closed circuit to catch and eject the defective assemblies.

Conclusion

In this brief summary, the aim was to show how automation has gradually evolved through a much longer period than is generally recognized. Whenever possible, credit to the man or organization was given in key spots. To the many others whose contributions have been overlooked, it is regrettable that present literature research methods, which are far from automatic, made it impossible to search out every step, nor did space permit the inclusion of all that was found.

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Manufacturing Engineering—

A Key to Increased Production and Lower Costs

Functions, organization, and some of the results obtained through the introduction of a department of "specialists" into the manufacturing organization in order to better solve manufacturing problems pertaining to cost, delivery, and quality.

By J. A. Miller

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Westinghouse Electric Corporation, East Pittsburgh, Pa.

Does your organization have a "key" which opens the door between engineering design and manufacturing processes? How often have you been confronted with the problem of either having a sound engineering design that costs too much to manufacture profitably or, conversely, a new manufacturing technique that apparently does not have application to existing designs? Certainly in this age of specialization of industrial personnel, these and many other problems involving the correlation of rapid advancements in both engineering principles and manufacturing techniques confront industrial management. Just as certainly, it is extremely difficult, if not impossible, to have within either of these two separate phases of an organization sufficiently experienced or trained personnel to correlate advancements.

Through the introduction of a third member to the organization, the Transportation and Generator Division of Westinghouse Electric Corporation has found a means of bridging this gap and providing a key with which to open this double-swinging door.

This third member of the organization has been called "manufacturing engineering." Its introduction has produced some outstanding results, and its role in the future planning of the division is becoming of increasingly greater importance.

Functions and Responsibilities

Basically, the manufacturing engineering organization is a staff function with direct responsibility to the manager of the manufacturing organization. As such, it is the responsibility of this group to assist him in the control of manufacturing costs and instigate whatever action is deemed advisable in the development of new methods, processes, or equipment to achieve this end. In addition, it is their responsibility to review and make recommendations on engineering designs that might lead to improvement from a manufacturing standpoint.

Control of Manufacturing Costs. The control of manufacturing costs probably is accomplished most satisfactorily through the action of a cost-reduction program which has been formed within the division. The responsibility for the co-ordination of this program lies with the manufacturing engineering department. This program has been so established that all basic functions of the operating division work jointly on reductions in material, labor, and overhead costs. Through the instigation of co-ordinators within the engineering, manufacturing, production, and purchasing departments and the establishment of various working subcommittees, the program is self-activating and perpetuating in nature. By establishing "bogies" or "goals" for each of the various committees, an over-all divisional cost-reduction program is obtained. Each of the subcommittees meets semimonthly and through the review of dockets on the ideas for cost reductions, which pertain to their particular activity, progress is systematically insured.

Outstanding results have been obtained through the cost-reduction program, not only in reductions in manufacturing costs but also in improved designs, better materials, and improved product quality.

Developing New Tools and Processes. One of the paramount problems, when products are generally not standardized, is in the development of new processes, tools, equipment, etc., with a minimum of lost production time. In general, the product repetition is limited to such an extent, and the apparatus is of such a physical size, that production and development must proceed hand in hand. One solution to this problem lies in the use of a manufacturing laboratory. The laboratory provides a means to overcome the problem of lost production time due to development and expedites development completion. It also provides a means of establishing the process completely, the sequence of operations, a time-study breakdown, and a place to systematically train operators. Development work, conducted by personnel genuinely interested in its successful completion, free from production-schedule pressure, and systematically conducted, is a most desirable goal.

Manufacturing Development Budget. One of the important factors in the successful conduct of development work is the establishment of a manufacturing develop-

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ment budget. This budget, annually organized and requested by the manufacturing engineering department, provides a means with which investigations and development work can be conducted in an expeditious manner. Appropriations for major expenditures generally are not included within this budget. Much information is gained by the expenditure of these funds in the investigation of new methods, processes, and designs. Manufacturing-process tests can be run in conjunction with engineering-design tests. Experience has shown that even though all such investigations are not successful, a sizable return on the over-all budget is obtained.

Production Schedules. The establishment of detailed routing to the proper manufacturing section and assistance in maintaining production schedules are other important responsibilities of the manufacturing engineering department. In general, routing is established on the basis of most economical manufacturing cost and, for this reason, the manufacturing engineer must keep abreast of new designs and the changes in manufacturing-process costs throughout the shop. It is his responsibility to confer with the interested line and staff personnel so that accurate manufacturing costs are available and agreement is reached on any changes in routing.

Assistance in maintaining production schedules is another function of this department. Technical assistance in overcoming production bottlenecks may be required. This may produce required changes in the manufacturing process, the application of special tooling or fixturing, or recommendations for the purchase of additional equipment. Often a review with the engineering department results in a change in design to alleviate the condition. As business cycles rise and fall, it is often necessary to send work to outside suppliers or obtain work from outside concerns in order to maintain properly loaded manufacturing facilities. Assistance to and co-ordination of efforts on the parts of these suppliers or customers is also a function of the department.

Co-Ordination With Others. The necessity for constant surveillance of manufacturing processes and sequences makes the manufacturing engineer a vital member in plans for the purchase of new equipment and the rearrangement of existing equipment. He is often called upon to establish the manufacturing facilities, floor area, and manpower requirements to produce new products or existing designs requiring a change. Changes in volume of business also often require the expansion or contraction of facilities to meet desired schedules or to minimize transportation and material-handling problems.

Close co-ordination with the design engineering department is a major responsibility of this department. Regularly scheduled visits to the engineering drawing department are made to review completed tracings with the engineering representatives. This review is made with the intent of noting and correcting problems which might occur. Frequent consultations are made at the time the tracings are on the drawing board. Such problems as finish requirements, welding requirements, tooling required, types of materials, suitability for efficient machining techniques, ease of assembly, and tolerance requirements are reviewed. A system requiring that all tracings receive a manufacturing engineer's initialed approval has been established, thus insuring that a thorough review is made of each new design. This approval must occur before the tracing can be released for manufacture.

In addition to the system of reviewing drawings, regular committees have been established within the engineering department and a manufacturing engineer is a regular member of each of these committees. Semimonthly meetings are held to review cost data on lines of apparatus. Those items requiring attention are scrutinized from a design standpoint with the intent of introducing design changes which will not only improve manufacturing costs but performance as well. Major reductions in cost have been achieved in this manner and such reviews have led to radical departures in design practices resulting in major design improvements.

Organization Structure

As in the case of any staff department, it is essential that the personnel within the manufacturing engineering department be so organized that their functions tie in directly with the other departments involved.

Engineering departments generally are organized by lines of apparatus or machines. The shop manufacturing sections, on the other hand, with the exception of assembly sections, generally are grouped by similarity of processes. Normally, this would mean that such operations as fabricating (burning, welding, shearing, etc.), machining, and other preassembly operations would be grouped together without too much regard for type of apparatus, with size being the main criterion for segregation. Other staff organizations then, generally, are patterned so that their structure is basically the same as one or the other of the foregoing organizations.

This condition, in the case of the manufacturing engineering department, which must function equally well in conjunction with both the engineering and manufacturing sections, creates a problem in organizational structure. Experience gained within the transportation and generator division, which has a multiplicity of products and a wide range of manufacturing processes, indicates that a single organization of manufacturing engineering is desirable. Basically, this organization is composed of two parts, under the guidance of separate supervisors, but co-ordinated within a single department by a departmental supervisor. One part of the organization consists of personnel who are grouped by lines of apparatus or products. These apparatus or product groups are directed by a group leader and have a responsibility for the over-all co-ordination of costs of a particular type of apparatus. The other part of the organization consists of personnel who are organized by manufacturing processes. These process or "service groups" act as consultants to the "apparatus groups" and, in addition, spend considerable time on the development of manufacturing processes in the combined apparatus-manufacturing sections. This organizational structure provides both over-all product co-ordination and, at the same time, provides a workable solution to the problem of manufacturing-process development with a minimum of overlapping of responsibilities and efforts. Maximum use is made of the talents of the entire group so that machining, fabricating, and other process experience is provided for all lines of apparatus, and projects which entail development common to more than one line of apparatus are easily co-ordinated.

Department Size

The correlation of the size of a manufacturing engineering department to the other phases of the division is a very important factor for consideration. It is also

necessary to consider the problem of personnel assignments within the department in relationship to the types and volumes of products being manufactured by the division.

In some lines of endeavor, it is possible to measure a man's worth directly in dollars and cents and, consequently, manning a department to the optimum point of return is easily arranged. In other cases, however, where a major portion of a man's work is involved in intangible and indirect costs, such a measurement is extremely difficult. Certainly it can be agreed that a return in divisional profits, which is three to four times an engineer's cost to the division in salary and indirect expenses, is a desirable circumstance.

A minimum figure of a return of 25 per cent over the cost to a division in salaries and expenses would represent a workable figure to use in establishing a departmental size. Another figure advanced is 1 per cent of a division's total personnel as being profitable in establishing the department size. Contributing factors such as rapidity of design changes, volume of sales, delivery-date requirements, and the organization and functioning of related staff departments all have a marked effect upon this establishment.

It is certainly difficult to measure the savings or improved product quality which might have resulted if there were sufficient personnel to investigate effectively the multitude of ideas which are originated. It is also true that the investigation of these ideas produces other ideas, which in effect create an ever-expanding field of investigation. Experience alone, in the final analysis, is the only certain method of establishing the size of the department.

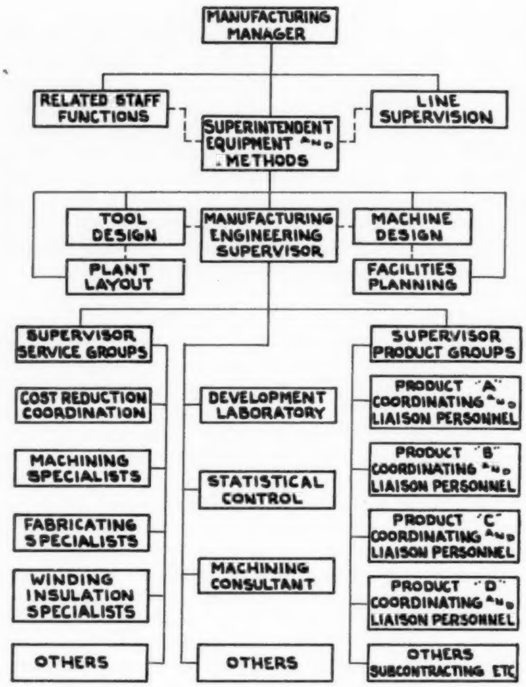

Fig. 1 Organization Chart for Manufacturing Engineering Department

Personnel Requirements

Basically, this manufacturing engineering department, Fig. 1, is composed of a combination of technically trained personnel working in conjunction with functionally experienced personnel. This, in view of the present general national shortage of graduate engineers, is, of course, of extreme importance. Present experience within the department seems to indicate, in addition, that this combination of personnel also results in a better working balance within the group. Shortcomings in practical experience within the manufacturing sections, on the part of the graduate engineers, are thus balanced by the experience of the functionally trained personnel and, conversely, technical knowledge and methods of analysis, lacking in the functionally trained personnel, are balanced by the engineering background of the others. This is important in order for such a department to function properly between both the manufacturing and engineering sections of the organization.

By nature of the manufacturing engineering department's functions, it is essential that, in addition to having a good technical or functional background, the personnel within the department have certain other personal attributes. In order to function properly with the many personnel of the other departments with whom contacts are made, the ability to express thoughts clearly, create good impressions, and think clearly, become of prime importance. The manufacturing engineer, in a sense then, becomes a combination of technician, salesman, politician, and analyst. Experience thus far gained indicates that a system of pretesting personnel before their addition to the group can do a great deal toward satisfying the stated condition. Correlation of these test results with job performance has proved this rather conclusively.

Training Ground for Management Personnel. It should be noted that the department serves the division as a valuable training ground for future management positions. Its wide coverage of work and the contacts that, of necessity, are made are valuable experience for potential supervisory personnel. Because of the high personal characteristics required of its personnel and the chance for observation of the performance of these individuals, many opportunities for advancement have been opened to personnel within the department. These personnel obtain a broader view of the division's operations than would be possible in almost any other line of endeavor.

Summary

The manufacturing engineering department is organized to serve as a control on manufacturing costs, product quality, and delivery completion. It has, from a standpoint of facilities, funds, and experience, the ability to review problems arising in either manufacturing or engineering, and through co-ordination of thinking and efforts on the part of both, expeditiously resolve the problems. Because of the nature of its work and freedom of movement, it is able to initiate or assist in the development and application of improved methods, processes, tooling, equipment, and work-area facilities. It has, through the resultant cost savings attained, proved that such a department can be a valuable asset to the operation of the division.

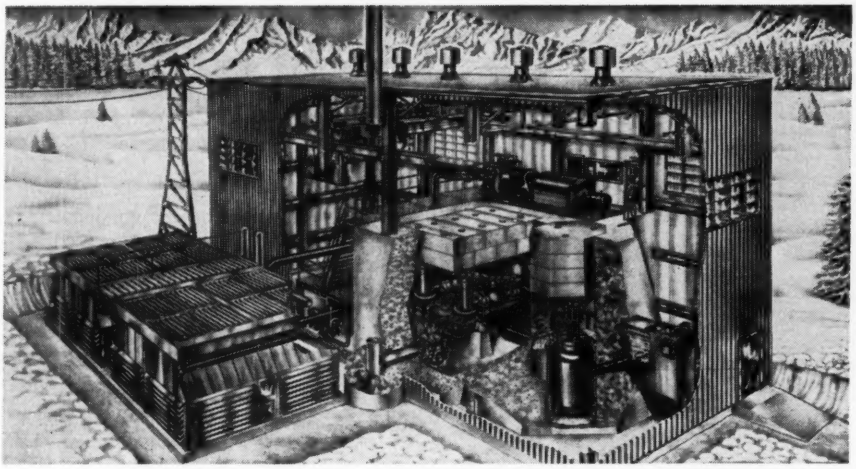

Fig. 1 Type of building planned to house Army Corps of Engineers package power reactor

Now the Package Power Reactor!

Army Engineers order a prototype plant designed to power remote radar stations

By A. L. Boch[1] and R. S. Livingston[1]

Electronuclear Research Division, Oak Ridge National Laboratory

In December of 1952, the Army Corps of Engineers established a small nuclear power group under Col. J. B. Lampert, whose function it was to investigate the possibility of using small nuclear-reactor plants to furnish power for remote areas. One of the major problems in maintaining the remote bases is that of furnishing supplies, particularly the fuel. It immediately becomes apparent that a reactor plant which can operate reliably for several years before refueling would reduce the supply problem substantially. Early in 1953 a small group was established at the Oak Ridge National Laboratory to evaluate the various reactor types and select one which appeared to be sufficiently developed to permit the design of a reliable inexpensive system which could operate long periods of time without refueling.

This paper describes the work done by a small group of engineers and physicists at the Oak Ridge National Laboratory on the conceptual design of a reactor capable of supplying heat and electricity for a remote location. The net electric-power and steam-heat output were selected to be 1000 kw and approximately 3500 kw, respectively. A typical plant of this type is shown in Fig. 1.

[1] Project Engineer and Director, respectively, of the Electronuclear Division. The Oak Ridge National Laboratory, Oak Ridge, Tenn., is operated by the Union Carbide Nuclear Company.

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General Description of Reactor

Site Conditions. One of the major factors which influences the design of the package reactor power plant in addition to the power output of the plant is the location. The typical application for which a nuclear power plant would be ideally suited is a radar station. These installations are of necessity in remote locations where accessibility must be limited to air transportation and where the construction period may be as short as 3 months per year. Therefore such characteristics of the site as weather conditions and terrain must be investigated in so far as they will affect reactor design.

Plant Operation. The power cycle is composed of two main systems, the primary coolant and the secondary steam systems. Associated with these are the auxiliary systems for the primary coolant make-up, the pressurizer, the space heating, the condenser coolant, and for the boiler-water make-up. Water circulating through the primary coolant system serves to transfer heat from the reactor core to the main heat exchanger where it is transferred to the secondary system. Steam generated in the heat exchanger drives the turbogenerator and also provides heat for building heating.

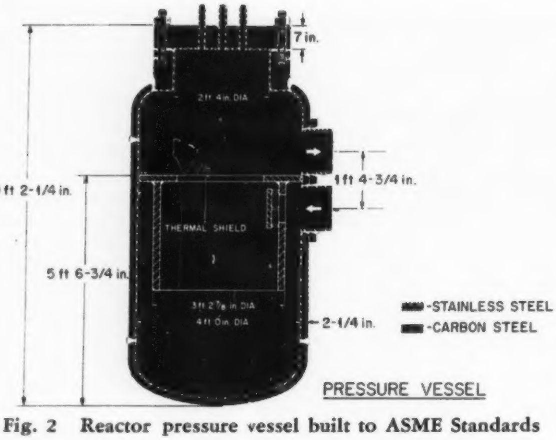


Fig. 2 Reactor pressure vessel built to ASME Standards

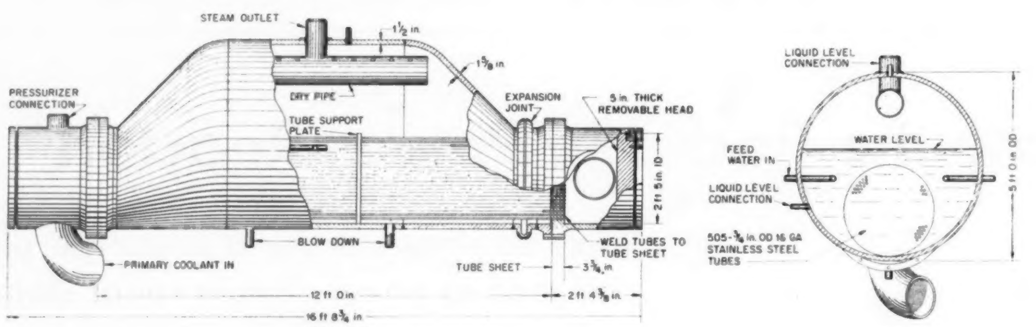


Fig. 3 Main heat exchanger for the generation of steam is a single-pass horizontal shell-and-tube type

The primary system consists of the following major items of equipment: The reactor pressure vessel, the pressurizer tank, two canned-rotor circulating pumps with their associated check valves, the demineralizer, a storage tank for make-up water, two filters, two make-up water pumps, and two seal pumps. Water for the primary system is obtained by periodically transferring a portion of the condensate from the steam cycle to a small make-up storage tank. A fixed amount of water is bled continuously from the primary coolant and discarded in order to maintain the low concentration of corrosion products in the system. To replace this, an equal amount of water from the make-up storage tank is passed through the demineralizer unit and filters and then injected into the primary coolant cycle by the make-up pumps. The hot primary coolant leaves the reactor core at the rate of 4000 gpm at 450 F, passes through the tube side of the main heat exchanger where heat is transferred to the steam cycle, and is returned to the reactor by the primary coolant circulating pumps. An electrically heated pressurizer attached to the high point of the system maintains a pressure of 1200 psia and thus prevents boiling in the pressure vessel.

The secondary system consists of the following items: The turbogenerator with its associated condenser and condenser-cooling system, heating-system condensate return, a steam-jet air ejector, two hot-well pumps, a deaerating feedwater heater and storage tank, two feedwater pumps, and the evaporator. The main heat exchanger is a component of both systems, the primary coolant passing through the tube side and steam being generated in the shell side.

Raw water for make-up in the steam cycle is converted to steam in the evaporator; in the deaerator this steam is combined with and helps heat the feedwater before it enters the heat exchanger. Steam generated in the main heat exchanger passes through the turbine and is condensed in the turbine condenser. The condensate is then returned to the deaerating feedwater heater by the hot-well pumps. Steam also is used to heat the evaporator, and in the steam-jet air ejector which maintains a vacuum in the turbine condenser.

Steam for the building heating load is taken directly from the heat exchanger, in parallel with the turbine load, and passes through a pressure-reducing valve to the building heating system. Condensate from this system is collected in a condensate-return unit consisting of a storage tank and two pumps which force the condensate back into the secondary system. Air coolers are pro-

Table 1 Design Data

Over-all plant performance	
Thermal power developed in reactor, kw	10000
Thermal power developed in reactor, Btu/hr	34.1×10^6
Electric power generated, kw	1300
Net electric power delivered, kw	1000
Power required for auxiliaries, kw	300
Steam heat load delivered, kw	3535
Steam heat load delivered, Btu/hr	12.1×10^6
Over-all thermal efficiency, per cent	45.4
Thermal efficiency of net electric power generation, per cent	15.5
Core life before refueling, mw-yr	15
Thermal Data of Reactor at Full Power	
Operating pressure in reactor, psia	1200
Coolant inlet temperature at reactor, deg F	432
Coolant outlet temperature at reactor, deg F	450
Properties of coolant:	
Density at 450 F, pcf	51.75
Density at 432 F, pcf	52.60
Change in density per deg F, pcf	0.046
Viscosity at 445 F, lb/ft-hr	0.295
Thermal conductivity, Btu/hr-sq ft-deg F/ft	0.39
Specific heat, Btu/deg F-lb	1.115
Coolant flow through core, single pass, gpm	4000
Coolant flow through core, single pass, lb per hr	1.66×10^6

vided to remove the heat from the main turbine condenser coolant.

Table 1 summarizes the design data for the package power reactor.

The Reactor System

The Core. The reactor core contains highly enriched uranium fuel in the form of convenient subassemblies. Sufficient uranium is provided in the core to enable the reactor to operate for 15 megawatt-years or for its full rated power continuously for $1^1/_2$ years. It has been calculated that less than 25 kg of highly enriched uranium will be required.

Pressure-Vessel Design. The reactor pressure vessel, Fig. 2, designed according to ASME Standards for Unfired Pressure Vessel, 1952 Edition, has a design pressure of 1250 psi and a design temperature of 650 F. The shell material is ASME Type-SA 212, Grade-B, firebox quality, boiler-plate steel.

The thermal stresses induced by nuclear reactions in the pressure-vessel wall were calculated as a function of wall thickness. For operation at 450 F, a 2-in. stainless-steel thermal shield reduces the tensile stress in the 2.250-in. vessel wall from 24,000 psi to 17,000 psi.

Control-Rod Drive Mechanism. A suitable design for a low-cost control-rod drive mechanism did not exist. The major problem was the introduction of linear motion inside a vessel at high pressure. The solution of the problem is to drive the rod by a rack and pinion located inside the pressure-vessel cover. Motion is transmitted to the pinion through a semicommercial rotary spindle seal. A motor package mounted on the reactor cover provides the motive force.

Heat Exchanger. The main steam generator, Fig. 3, for the plant consists of a single-pass, horizontal shell-and-tube-type heat exchanger. The primary coolant water flows through the tube side and steam is generated in the shell side. A simple dry-pipe arrangement provides dry steam at the outlet. Under partial loads the steam-generator pressure is greater than the full-load value of 200 psia, ranging upward to a maximum of 423 psia at no load. A pressure-reducing valve is used to maintain steam pressure at the turbine throttle constant at 192 psia.

Reactor Control System

The system used for control of the reactor consists of two sections,

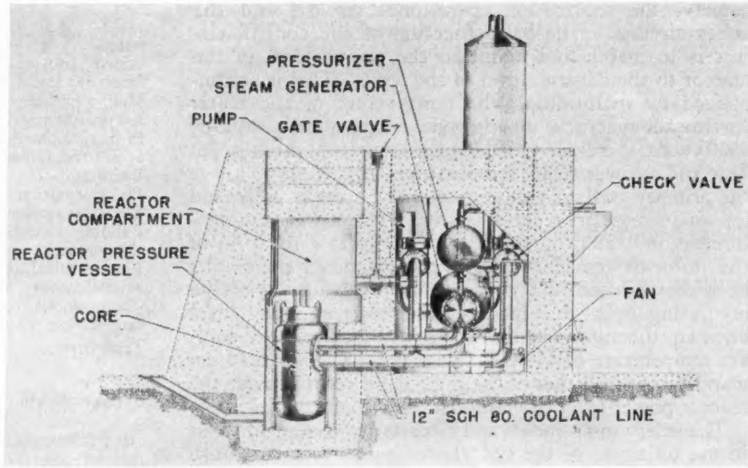


Fig. 4 Reactor primary coolant system, equipment layout, vertical section

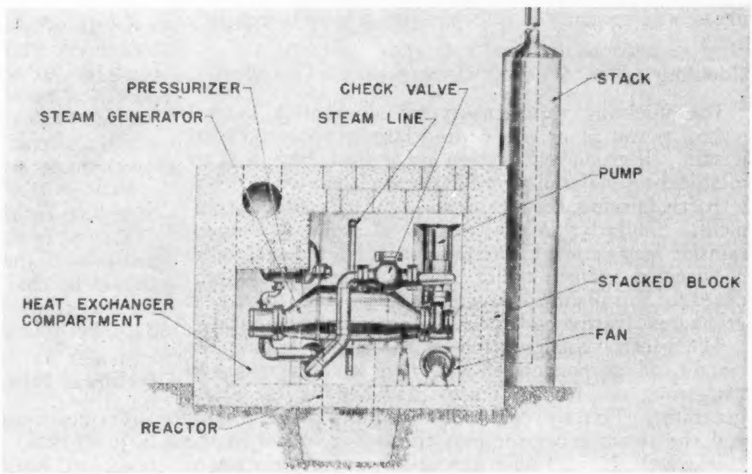


Fig. 5 Primary coolant system, showing the heat-exchanger compartment

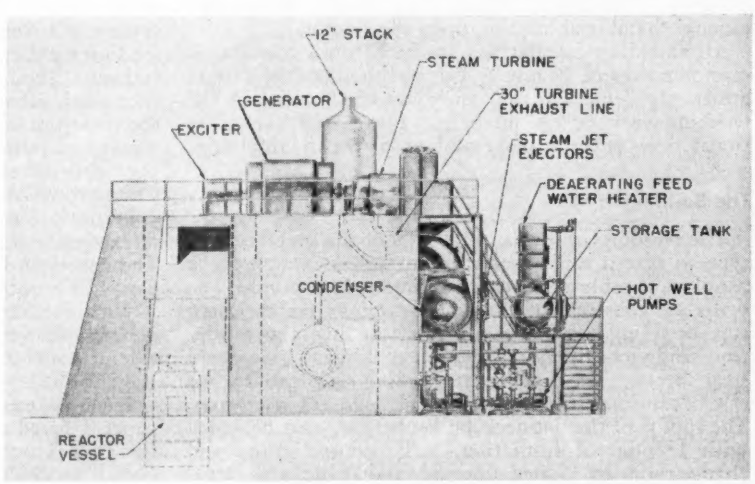


Fig. 6 Steam and auxiliary equipment of package reactor, side elevation

namely, the control or operational circuits and the safety circuits. The basic function of the control circuit is to match and maintain the power level of the reactor to the demand level of the load. This is accomplished by maintaining the temperature of the water leaving the reactor at an approximately constant value of 450 F. An increase in load demand results in more steam flow and a lower steam temperature; this tends to lower the primary coolant temperature and results in a demand for an increase in reactor power. The lower temperature, as indicated on the recorder, effects a rotation of the motor-driven demand-level potentiometer and results in a signal to the servo system for withdrawal of the regulating rod; this increases the reactor power level until equilibrium is again established at a primary coolant temperature of 450 F. Conversely, a lower load demand causes insertion of the regulating rod to lower the reactor power level to match the new load conditions.

The safety instruments and circuits are similar to those in use on many of the ORNL designed reactors. Both reactor-period and flux safety circuits are provided. Emergency scram buttons are located at strategic positions throughout the reactor plant for use by personnel in case an emergency shutdown of the reactor is required.

Shielding

The shielding requirements for a remotely located reactor power plant will depend largely upon the local terrain. If ground excavation is practical, large savings in shielding material may be accomplished by burying, or partly burying, the reactor and primary coolant equipment. Similarly, proximity of the plant site to a mountainside may permit material savings if the plant can be constructed against a cliff. The concrete shield proposed for this plant is designed with the assumption that ground excavation and rock shielding are impractical.

The general configuration of the shield around the reactor and components, shown in Fig. 4, forms two compartments, one for the reactor and one for the steam generator. Primary coolant pipes joining the reactor and the steam generator pass through a tunnel in the shield wall, located off-center relative to the reactor to prevent streaming of radiation through it.

The pit containing the reactor vessel is only 6 ft in diameter; it is located eccentrically below the 8-ft octagonal chamber above the top of the reactor.

All shielding calculations are based on a continuous reactor power of 10 mw. The permissible dose rate is arbitrarily defined at 300 mrep absorbed over a 56-hr working week, or 5.36 mrep/hr. Figs. 5 and 6 are additional views of the primary coolant system and shielding.

The Building

The building, shown in Fig. 1, is of the prefabricated type to permit rapid erection yet rugged enough to be readily adaptable to meet severe climatic conditions. The walls are constructed from a lightweight prefabricated type of siding consisting of $1^1/_2$ in. of Fiberglas insulation sandwiched between two fluted 18-gage galvanized steel sheets. The prefabricated siding slabs provide for ease of transportation and yet a high degree of insulation. The roof is of the flat-deck built-up type, also provided with $1^1/_2$ in. of insulation. The control room and change room are located alongside and at the same elevation as the top of the reactor shield.

Table 2 Capital Costs

Reactor	$ 148,000
Primary coolant system	357,000
Steam system	171,000
Main condenser cooling system	61,500
Evaporator system	22,000
Primary coolant water-purification system	32,000
Pressurizer system	40,500
Instrumentation and controls, reactor	82,000
Instrumentation and controls, process	38,500
Electrical systems	82,000
Building, including crane, platforms, and ventilating equipment	260,000
Reactor shielding (500 cu yd)	70,500
Miscellaneous	42,000
Contingencies, 10 per cent	140,700
Engineering, 10 per cent	155,300
Total cost	$1,703,000

Cost Analysis

In preparing the following estimates, Table 2, the best information from various sources was used. All major plant components were so engineered as to enable several reliable manufacturers to quote fabrication costs.

The costs are believed to be realistic for construction at a developed site similar to Oak Ridge, Tenn. No attempt was made to estimate the costs for construction of the plant at remote locations where labor and transportation costs could be expected to run substantially higher. The estimated cost for the plant is $1,703,000; additional costs would be incurred to cover any further development work which might prove necessary.

Installed Plant Costs per Kilowatt. The reactor will produce 1000 kw net electrical power and 12.1×10^6 Btu/hr (3535 kw) in the form of steam for heating purposes. An analysis of the plant costs indicates that 45 per cent should be charged to steam and 55 per cent to electric power. This gives $936/kw net electric power and $216/kw steam heat.

Prototype Plant to Be Built

The conceptual design study described was completed in July, 1954. The preliminary development work had proceeded satisfactorily and in order to verify the objectives of the design and to evaluate the performance of a power-generating system so radically different from those with which industry has had experience, it was deemed prudent to complete the development program by assembling and operating a full-scale prototype generating station. The conceptual design prepared at ORNL was then used, after certain designated modifications of the specifications, as a basis for obtaining a number of lump-sum proposals for the design, construction, and test operation of this reactor plant at Fort Belvoir, Va. Thirty-three contractors were invited to bid.

Invitations to bid were issued on August 19, 1954, and on November 19, 18 companies submitted firm proposals. The American Locomotive Company was successful bidder. The contract price was $2,096,753.

With the awarding of this lump-sum contract it is believed that the door has been opened for the nuclear-reactor plant to emerge from the laboratory experiment stage to the beginning of the practical power-supply era.

Acknowledgments. Design studies upon which this paper is based were prepared by members of the staff of the Oak Ridge National Laboratory Package Reactor Group under the guidance of the Package Reactor Steering Committee.

DANGERS AHEAD

... for the Engineering Profession

Threats to the engineering profession arising from competitive bidding for services, advertising by consulting engineers, and engineering by contractors and manufacturers

By N. T. Veatch[1]

Black and Veatch, Consulting Engineers
Kansas City, Mo. Fellow ASME

While every engineer, regardless of where he is, or what he is doing, should be interested in anything that will add to the prestige of the profession, the following statements are directed primarily to members of national engineering societies engaged in the practice of consulting engineering. The number of members of the several societies employed in consulting work represents a large segment of the total membership of such societies. Also this group has perhaps a greater obligation to the profession than any other, as the perfection of its accomplishments and its adherence to ethics of practice are constantly under the scrutiny of the general public.

Those engaged in consulting practice consist of members of many different organizations varying in size from the individual consultant with few if any associates, to large firms equipped to handle projects of any magnitude and complexity. There are firms of all sizes specializing in many divergent lines, such as mechanical, electrical, and hydraulic engineering. There are also many large organizations qualified to handle all phases of large projects. These latter firms usually have been developed over a long period of time and include experts in all the major branches of engineering. Among all of the aforementioned types of consultants there is a difference in age and experience of the members of the organization. With all of the many groups both large and small, and of varied training and experience, that are covering the myriad special lines of engineering work, it is to be expected that the degree of perfection, so far as final results are concerned, will vary. After all, it is impossible to get away from the fact that good engineering is the product of man's brain, either individual or collective, and there is no common yardstick to apply to such service. The real measure of service lies in the production of final results in the most efficient and economical way.

Anyone engaged in engineering work can do many things to enhance the standing of the profession in the minds of the lay public. Undoubtedly one of the best means of doing this is by rendering better and more efficient service. It is believed, however, that there are a few aspects of professional conduct within the profession itself that present a real threat to it, and the correction of these faults will go a long way toward enhancing the standing of the profession.

The question of proper professional conduct within the field of engineering practice is receiving a great deal of study by many of the leading engineering societies. It is well that this is so since the accelerated tempo of the current economy has engendered many new organizations dealing wholly or in part with engineering matters as well as many which offer various combinations of engineering service, contracting, and manufacturing. The very nature of the activities of many of the new firms, as well as that of some of the older ones, has placed emphasis on the commercial rather than the professional viewpoint and it is at least conceivable that this situation, if not controlled, may force the public to consider engineering as a commercial activity rather than a profession. The architects have given this subject a great deal of attention and in many respects they are ahead of the engineers.

The time has come when it is necessary for those of us engaged in the practice of engineering to decide whether we are members of a profession and to act accordingly, or whether our activities are commercial and to govern ourselves by commercial standards. Only those within the profession itself will or can do anything about the situation, and since the only bodies that are in a position to speak for the profession are our engineering societies, the danger of making a wrong decision is a definite challenge to these societies.

While the engineering profession is actually very old, it has been recognized as a truly learned profession for only a little over a century. Comparatively speaking, it is the youngster of the accepted professions but it has earned a status of which we are justifiably proud. This status is the result of long and conscientious effort on the part of many fine individuals. It would be a shame to allow unprofessional practices which detract from the high standing of the profession to continue with anything that even gives the appearance of consent.

The following subjects are believed to justify special attention from the national societies because, if not properly controlled, they will certainly undermine the profession.

*1 **Competitive Bidding for Professional Engagements.*** Instances of competitive bidding for professional services

[1] Mr. Veatch is a member of the ASME Committee on Professional Practice of Consulting Engineering. The opinions expressed in this paper are those of the author and not necessarily those of the Committee.—Editor.

seem to be increasing in number. There are cases where bids are actually requested as well as submitted by members of the leading engineering societies and under circumstances which indicate clearly that price is the controlling consideration.

2 *Advertising.* The use of display and sometimes self-laudatory advertising on the part of members of the profession are also becoming more prevalent. Most of these cases involve those who offer a combination of engineering service with construction or manufacturing.

3 *Engineering by Contractors and Manufacturers.* Engineers employed by contractors and manufacturers have made outstanding contributions to society and to the profession. Everyone should be grateful for this contribution. However, there are quite a few cases where a contractor is given a contract under which engineering is also furnished. The circumstances surrounding such arrangements determine whether such a plan is to the best interests of the client. Also, there is a practice among some of those engaged in the consulting field to allow contractors and manufacturers to do engineering work which they, the consultants, should do themselves and by so doing have often brought about improper and expensive design.

The foregoing list is by no means complete but most of the transgressions in question seem to fall into one of the three categories. In this discussion, fraud and other crimes under civil law have not been considered.

Competitive Bidding

Competitive bidding is believed to present one of the gravest dangers to the engineering profession. Its universal adoption on the part of the engineer and the client would end any justification for engineering being considered a profession.

Competitive bidding is well established as a proper and many times a desirable practice in commercial-business transactions. It has not been a serious problem in any of the other learned professions due to discipline within their own ranks. It has become a real problem in engineering perhaps because the engineer is usually directly concerned with projects involving competitive bidding and the expenditure of large sums of money.

Engineering is the most essential component of every item of construction or manufacture, be it a sidewalk or a battleship, and since competitive bidding is adaptable to most of the other components, it requires some careful thinking to realize that the temptation to include engineering service in a bid is actually not to the best interests of the owner or client.

It is believed that competitive bidding may be properly used for anything that may be adequately specified, but no one can adequately specify the workings of a man's brain. That is exactly what is involved in engineering service. If there is any single lesson to be learned from centuries of professional experience it is that brain power cannot be and should not be standardized.

There are many circumstances presented to the practicing engineer in the requests received for information regarding his services. The requests range from a statement that bids, sometimes designated as sealed bids, will be received at a certain date and time and then publicly opened, to one which states the engineer has been selected to perform certain services and asks for a formal proposal. At times there is even a formal advertisement for bids. Requests for competitive bids on a price basis whether by letter or through a formal advertisement or the submission of a proposal in response to them would be clearly an infringement of the codes of the leading engineering societies.[2]

There are other circumstances where the proper procedure is not so clearly defined. It is believed that from a practical standpoint, a prospective client can very properly consider the amount of fee to be paid, as well as the qualifications of the engineer. The real purpose of the several codes is to require members to adhere to practical professional standards in connection with the engagement of engineering services. Manifestly the selection of an engineer for any particular task should not be based solely upon his fee, as the interest of the client lies in the total cost of the project rather than the cost of engineering. This is the main reason the societies have in their codes of ethics an article prohibiting competitive bidding, for often, if not generally, employment of an engineer with less experience and with the lowest fee will result in either a higher total cost or an inadequate design.

It must be recognized that there will constantly be new faces appearing in the consulting field, and such individuals or firms must get a start, and that only time and experience can make their services comparable to those of older ones. Naturally, these younger consultants will and can furnish services for lower fees than those having more expensive operations. These newer firms or individuals have a very proper place in the profession as they will someday be the leaders and there are many projects upon which their services are entirely satisfactory. However, the clients' interests will always be best served if selection of engineering talent be governed primarily by qualifications needed for the particular project and with the fee being entirely secondary.

It is believed that all of the practical requirements of the prospective client can be met and at the same time meet the full intent of the several codes. There is no reason why an engineer cannot discuss his fee with a prospective client whenever he is asked to do so. The only prohibition to his doing so is that he does not submit a fee when he knows that it will be solely controlling in the selection. It is also believed that each engineer will always know what the circumstances are in connection with any particular project on which he is either asking for consideration or where he is responding to some form of request. It would certainly be proper for an engineer to state his fee for his engineering services during negotiations after he has been selected by the client on the basis of his professional qualifications and ability to perform the services.

A recent instance of competitive bidding is worth citing as it resulted in the expulsion of one member of the American Society of Civil Engineers and suspension of membership of others.[3]

Late in 1953, the State Highway Commission of South Carolina found itself with more work than could be handled by its own engineering department and decided

[2] On recommendation of the Committee on Professional Practice of Consulting Engineering the Council of The American Society of Mechanical Engineers, on Nov. 28, 1954, adopted a "Statement of Policy on Publicly Advertising for Bids for Professional Engineering Services."—Editor.

[3] See *Civil Engineering*, September, 1954, p. 78; Also a pamphlet, "Negotiated Engineering Contracts Protect Public Interest," issued by Committee on Professional Practice, American Society of Civil Engineers, February, 1955, Appendix A.—Editor.

to employ an engineering firm to prepare plans and specifications for certain structures. Bids from engineers were requested by advertisement in the manner customarily used for obtaining bids from contractors. Fifteen engineering organizations responded. The "bids" ranged from 2.8 to 7.25 per cent of the contract cost of the work and the contract was awarded to the lowest bidder.

It is difficult to believe that either the services contemplated by all of the "bidders" were identical or that all of the "bidders" were equally competent. "Plans and Specifications" for a *bridge* were specified but the essential matters of quality of plans and competence of engineers were not. It seems probable that the client not only paid the lowest fee but also may not have got the best in service. In this instance, the interests of the client and the public as well as those of the engineer were involved and the unmistakable lesson it teaches is that competitive bidding failed to serve any of these interests whereas compliance with proper ethics would have served all of them.

Competitive Bids Required by Law

It is very common to find provisions in state laws or city ordinances to the effect that every contract which involves more than a certain sum of money shall be awarded to the lowest bidder after public advertisement and such provisions have been cited as a reason for compelling competitive bidding for professional services. Fortunately this is not the case. The courts, through a large number of decisions, have held that provisions as to competitive bidding do not apply to contracts for personal services which depend upon the particular skill of the individual, such as the services of an attorney at law, a superintendent or architect, or a consulting and supervising engineer, and generally that the provisions do not apply to the employment of a professional man, in which case the authorities have a discretion as to his qualifications.

The language of some of the decisions is enlightening. The Supreme Court of Colorado in a decision involving the employment of an architect stated: "We now say that anything said in those cases that may be construed to be a holding that the charter provision is applicable to a contract for architectural services is overruled, and we accept with complete approval decisions of other jurisdictions, including California, Indiana, Massachusetts, Minnesota, New York, North Dakota, Ohio, Pennsylvania, and Texas, holding that a municipality can contract for the services of an architect without complying with such a requirement as is contained in the charter section in the present case."

"We are satisfied to accept and adopt the following language.... The value of such service is not to be measured by a mere matching of dollars, so to speak; it is not to be determined upon the irrational assumption that all men in the particular class are equally endowed with technical or professional skill, knowledge, training, and efficiency. Nor are such services rendered more desirable because offered more cheaply in a competitive-bidding contract. The selection of a person to perform services requiring those attributes calls for the exercise of a wise and unhampered discretion in one seeking such services, for it involves (not only) personal and professional trustworthiness but responsibility as well."

The virtually unanimous action of the courts on this subject constitutes recognition of the professional status of engineering from a most reliable source. Competitive bidding is demonstrably unnecessary, unreliable, and unsatisfactory and we are deeply indebted to our engineering societies for declaring it contrary to proper ethics.

Advertising

Advertising has been a ticklish subject in professional circles for many years. The general consensus seems to be that, where such services are involved, advertising should be limited to a professional card which states that the individual (or firm) is practicing a certain profession at a certain address.

The Code of Ethics of the American Society of Civil Engineers (Article 7) states that it shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member: "To advertise in self-laudatory language or in any other manner derogatory to the dignity of the profession."

Other societies have similar code provisions[4] and it is clear that in the minds of these leaders of the profession, advertising, in the usual sense of the term, is not ethical.

The Committee on Professional Practice of the American Society of Civil Engineers has commented as follows in the attempt to clarify the situation. Within the meaning of the Code, the Committee is of the opinion that:

"Engineering firms and individuals offering professional services to the public may properly advertise such services by procuring the publication of a professional card in any magazine of technical or professional character having a section specifically designated as a professional directory. Such professional cards shall include *only* the name and business address of the firm or individual, the names of key personnel, and the scope of the services offered. The size and form of such professional cards shall be such as to avoid undue display and shall be in general conformance with such cards appearing in the Professional Directory of *Civil Engineering*, an official publication of the American Society of Civil Engineers."

"Such professional cards may not properly be displayed in any newspaper, nor in magazines of nontechnical or nonprofessional character, nor in any publication which does not regularly carry a classified section specifically designated as relating to the practice of professional engineering."

"Engineering firms and individuals offering professional services to the public may properly distribute to prospective clients brochures or booklets, containing a list of completed professional engagements, descriptions of all services offered, factual statements of accomplishments and qualifications of key personnel, and descriptions, photographs, and/or other illustrations of works upon which their professional services have been employed. Such brochures or booklets may not properly

[4] The By-Laws of The American Society of Mechanical Engineers, Art. B15, Professional Practice, Par. 1, state: "All members of the Society shall subscribe to the following Canons of Ethics for Engineers as required by the Constitution." The Canons follow in full. Section 2 of the Canons states: "He (the engineer) will not advertise his work or merit in a self-laudatory manner...." The Canons, originally prepared by the Ethics Committee of Engineers' Council for Professional Development have been adopted or endorsed by more than 80 engineering organizations.—Editor.

include the advertisement of any commercial product or equipment, nor any self-laudatory statements. They shall be in all respects of a character tending to uphold the dignity of the profession."

"Engineering firms or corporations offering, in addition to professional engineering services, such other services as construction, management, financing, and personnel employment, may, under similar restrictions as to content, distribute brochures or booklets, covering all services offered, including professional engineering services. They may not, however, advertise the essential combination of professional engineering services with other services either in such brochures or booklets, or in any display advertisement in a publication of general circulation, nor by direct statement or implication combine an offer of professional engineering services with an offer for such other services."

It would seem that there should be little chance of misunderstanding the spirit of this section of the Code. Essentially it is the dignity of the profession that is at stake and common prudence suggests that the proper course of action lies in the "avoidance of the appearance of evil."

It is difficult to conceive of a situation in which the return from an unrestricted advertising program to an individual engineer or firms of engineers would be sufficient to compensate for the sacrifice of professional standing, but even if the return should appear adequate to the individual the societies should maintain the right to disciplinary action in case a member is involved.

Engineering by Contractors and Manufacturers

From the ethical standpoint matters get quite involved when engineering service is combined with construction.

It has been said that "one cannot umpire and play in the same ball game" and the logic of this philosophy must be admitted. So it seems that the criterion, when engineering service is concerned, is whether the engineer is offering his services as an "umpire" or as a "player." This foregoing statement stretches the metaphor a little but is intended to differentiate services as a representative of the client from those as a representative of the contractor.

It is conceivable that the owner may be an engineer or have regular employees who are competent to judge engineering and desire to have the project designed and constructed under a single contract. Such arrangements are in fact common in industrial work. Engineering organizations considered are carefully screened prior to the negotiation of a contract and finally the functions of the engineer so far as ethics is concerned are performed by the owner or his employees. In other words, an umpire may not be needed.

If, on the other hand, the owner is not prepared to do his own engineering and is in need of such services he must look to the profession and the matter of ethics is most important. His game needs an umpire and one who is above any suspicion of bias. He cannot afford to take chances and it is with the interest of clients of this type in mind that the societies have incorporated provisions of the following nature in their codes of ethics.

"It shall be considered unprofessional, etc., to act for his clients or for his employers in professional matters otherwise than as a faithful agent or trustee, or to accept any remuneration other than his stated charges for services rendered his clients."[5]

Some manufacturers of various types of equipment will, on request, provide engineering services in connection with plant design and some consulting engineers will incorporate the results of such engineering work in the plans furnished the client. This situation abounds in "borderline" cases so far as ethics is concerned but the main point is that a client has the right to expect the consulting engineer to perform services himself and not to delegate his responsibility. The fault seems to be divided between the manufacturer and the engineer, but from the standpoint of ethics the responsibility must lie with the engineer who permits such procedure.

Remedial Measures

Two facts seem to be quite clear:

1 Indifference to code violation on the part of the profession itself is certain to be construed by the public as acceptance on the part of the engineers.

2 Any remedial action to be effective must be taken by the societies for the reason that only they are in a position to speak for the profession and to impose disciplinary action.

A third and rather obvious fact, so far as the public is concerned, is that action by all of the societies must be along parallel lines and the similar nature of the ethical codes of the several societies gives assurance of the possibility of such action.

It is wishful thinking to believe that dangerous practices can or will be entirely eliminated by any action on the part of the profession. Centuries of legislation have failed to stop crime but have made it very unpopular and it seems probable that appropriate action by the societies can reduce greatly the number of code violations.

It should be remembered that every society member has subscribed to a code of ethics and that in the final analysis no member need be asked to do anything that he has not already promised to do in order to follow the code.

The real problem is, has been, and will be, the interpretation of the several codes and this means work for our Committees on Professional Practice. Each actual or alleged violation must be considered on its individual merits by competent persons and it is the spirit rather than the language of the code provisions that must be upheld.

Some of our codes have been criticized as being too harsh and in not a few cases changes have been suggested, but generally the spirit has not been questioned. We must be ever on the alert lest by trying to improve our codes we open up additional loopholes for use by those who desire them. "Thou shalt not steal" seems rather short and abrupt if not actually harsh, but no one has attempted to challenge its meaning. It certainly would not be helpful for this commandment to be amended to read: Thou shalt not steal except under the following circumstances, etc.

Our societies probably cannot stop all code violations but they can maintain discipline among their members and when this is accomplished the profession will be in a vastly improved condition. We can bring this about but we must keep "on our toes" to do it.

[5] Article 1, Code of Ethics, American Society of Civil Engineers. The Code appears in the pamphlet referred to in footnote 4.—EDITOR.

Recent Progress in
HYDRAULIC PRIME MOVERS

Compiled by Hydraulic Prime Movers Committee, Hydraulic Division of the ASME

Although the Hydraulic Turbine Industry is more than 100 years old, there has been considerable progress in technological and mechanical features of hydraulic prime movers and their auxiliaries during the past few years. Reports regarding such progress have been obtained from some of the manufacturers and form the basis of this review.

Allis-Chalmers Manufacturing Company

Reversible Pump-Turbines. One of the most interesting developments in the hydroelectric industry in recent years has been the reversible pump-turbine, which operates in one direction of rotation as a turbine to produce power and in the opposite direction as a pump to pump water, the hydraulic unit being connected to a single electrical unit which serves as both a motor and generator. This type of unit has found application in pumped storage projects, which are being given serious consideration in connection with large-capacity steam-turbine units.

For the Bureau of Reclamation's Flatiron Power and Pumping Station near Loveland, Colo., the company designed and built the first reversible pump-turbine unit on the North American Continent. The unit has a rated pumping capacity of 370 cfs at 240-ft head and a rated output of 10,250 hp at 250-ft head. The unit (hydraulic and electrical) which the company furnished complete operates at 300 rpm as a pump and 257 rpm as a turbine. It was placed in operation on March 1, 1954, and has given satisfactory performance. The field acceptance test of the unit showed a maximum efficiency of 91.0 per cent as a pump and 88.8 per cent as a turbine.

The world's largest reversible pump-turbine which was designed and built by the company is now being installed at the Hiwassee Plant of TVA. It is rated 80,000 hp at 190-ft head as a turbine, and has a rated capacity of 3900 cfs at 205-ft head as a pump. The motor-generator also designed and built by the company has a rating of 70,000 kva as a generator and 102,000 hp as a motor. This unit is scheduled to start operation before the end of 1955. See Fig. 1.

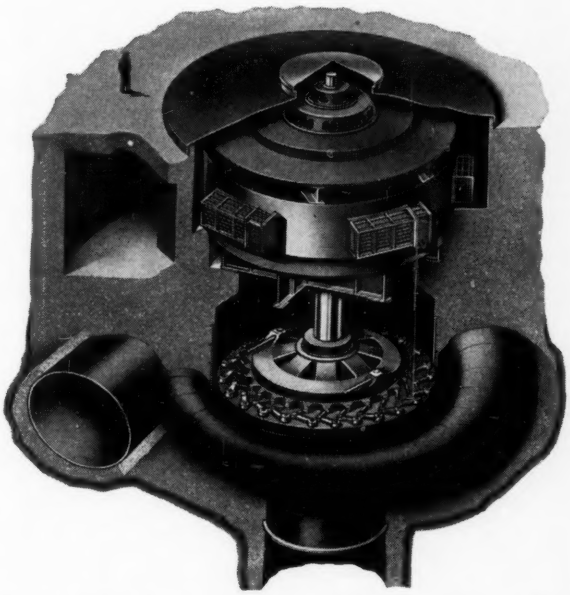


Fig. 1 Artist's drawing of largest electric motor and reversible pump-turbine ever built. For 1955 installation at Tennessee Valley Authority's pump-storage project at Hiwassee Dam. Rating 80,000 hp at 190-ft head as a turbine, 70,000 kva as a generator, 102,000 hp as a motor, 3900 cfs at 205-ft head as a pump. Speed 105.9 rpm.

Vertical Multijet Impulse Turbines. Recent successful installations of vertical 4 and 6-jet impulse turbines have revived interest in this type of unit for heads around 1000 ft. Since these units have been showing efficiencies in the neighborhood of 92 per cent, they are comparable to Francis units and have the additional advantage of high efficiencies over a wide range of load. The use of multiple jets permits more favorable speed ranges as compared to Francis units for heads over 1000 ft.

The company designed and built a vertical 4-jet impulse wheel for the Kemano Plant of the Aluminum Company of Canada. It is rated at 150,000 hp at 2500-ft head. The unit was placed in operation in July, 1954. A recent field performance test showed a maximum efficiency of 92 per cent with efficiencies above 90 per cent from full load to 48 per cent load. The single bucket wheel is of integral welded construction using pressed-steel buckets, which is one of the first wheels of this type ever built.

A 6-jet vertical impulse wheel was designed and built for the San Bartolo Plant in Mexico. The hydraulic turbine rated 39,000 hp at 1233-ft head, 428 rpm will be

Contributed by the Hydraulic Prime Movers Committee, Hydraulic Division, of The American Society of Mechanical Engineers.

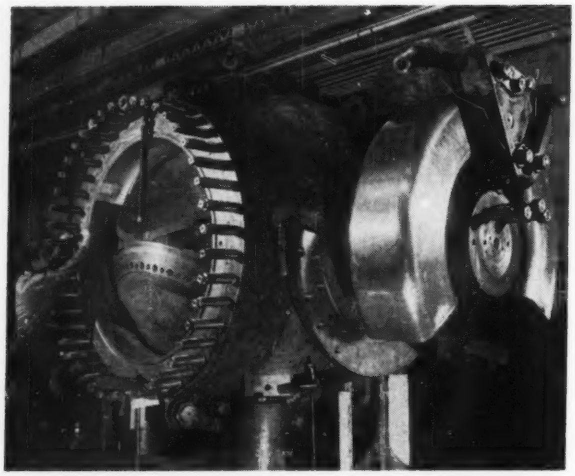


Fig. 2 Shop assembly of 63-in. rotary valve (downstream end), showing rotary piston secured to 30-in. lever. One of five such valves for Forcacava Plant, Rio de Janeiro Tramway Light and Power Company.

direct-connected to a 28,000-kva 13,200-volt Allis-Chalmers generator. This unit is now being installed.

The single bucket wheel is also of the integral welded-construction type using pressed-steel bucket bowls.

Rotary Valves. The rotary valve, or spherical valve, is definitely replacing the older type of gate valve and Johnson valve for high-head installations, because of its more economical construction. It is also giving competition to butterfly valves at heads above 700 ft because the rotary valve is practically drop-tight under full pressure and presents no obstruction to the flow such as the wicket in a butterfly valve. The absence of such obstruction eliminates flow disturbances and friction losses, permitting the use of higher velocities through the valve.

Another recent development with rotary valves has been the double seal or double-seat feature, with a seal on both the upstream and downstream end of the rotor. This permits removal for repair or replacement of the downstream seal, ordinarily used for service, while the upstream seal is closed against full water pressure.

The double-seal valve therefore functions as a guard valve in addition to a service valve and eliminates the necessity for an additional guard valve.

The company has recently designed and built the following rotary valves:

Plant	No. valves	Diameter, in.	Design head, ft
Patla, Mexico	3	42	765
Cubatao, Brazil	6	47$^1/_4$	2770
San Bartolo, Mexico	1	48	1500
Forcacava, Brazil	5	63	1295

The five valves for Forcacava and the six valves for Cubatao had the double seals. All of these valves are in operation and have given satisfactory performance. The Forcacava valve with a doughnut-type operator is shown in Fig. 2.

Kaplan Trunnion Bearings. Recent Kaplan turbine installations have been designed to incorporate antifriction bearings, providing greater ease of runner-blade rotation. The roller bearings have had quite wide acceptance in a variety of installations where they have all proved entirely satisfactory.

The fifth and sixth 48,000-hp 43-ft-head Kaplan units for Pickwick Landing, TVA, were provided with roller bearings as were the six 34,000-hp 45-ft-head units recently installed at Rock Island. The 24-ft 4-in. runners at Pickwick are still the largest in the United States. Those at Rock Island are 18 ft, 10 in. in diam.

Stainless Propeller Blades. Instead of the usual stainless-steel overlay on the outer peripheries and on the undersides of the Kaplan runner blades, entire blades of cast stainless steel are finding greater acceptance and approval. Solid-cast stainless blades, while more expensive, provide a more desirable job with smoother surfaces. Five Kaplan units under design or construction will have advantage of solid-cast stainless-steel blade construction.

Unique Unit Without Guide Vanes. A small hydroelectric unit of special unique design for the Paint Creek Plant of the Wisconsin-Michigan Power Company was placed into operation. It consists of a 155-hp 514-rpm fixed-blade propeller turbine operating under a head of 20 ft and direct-connected to a 100-kw 480-volt induction-type generator which is designed for full runaway speed. The unit is not required to do any regulation and has no governor. Water is admitted to the unit by means of a head gate and is directed to the runner by a series of stationary guide vanes.

Baldwin-Lima-Hamilton Corporation—Eddystone Division

Francis Turbines. During 1954, shipment was made of major components of the three Francis-type turbines for the Garrison Project, Corps of Engineers, U. S. Army, located on the Missouri River, north of Bismarck, N. D. Each unit is rated 88,000 hp, at 90 rpm under 150-ft effective head. The runner of each turbine is an integral steel casting with a maximum outside diameter of 222 in. and weighs about 190,000 lb. This is a record size and weight of one-piece runner.

The Garrison turbines are of the conventional vertical-shaft single-runner type having riveted-steel spiral housings with 22-ft 4$^3/_4$-in-diam inlets.

During 1953 the initial phase of construction of the Ross Powerhouse in Seattle, Wash., was completed and three 120,000-hp 150-rpm vertical turbines were placed in service under 355-ft head. The turbines are of special design to accommodate new 140,000-hp runners to operate under 440-ft head when the dam is raised at some future time.

Propeller Turbines. The Kaplan-type adjustable-blade propeller turbine continues to find wide application under low heads, where a wide range in head and output occur. An outstanding installation which was started in 1953 is the Dallas Development on the Columbia River, near Portland, Ore., by the Corps of Engineers, U. S. Army.

The initial project includes 14 vertical adjustable-blade propeller turbines, each rated to develop a normal output of 123,800 hp at 85.7 rpm under 81.0-ft effective head, and to have a maximum output of 130,300 hp. These are the largest in rated capacity now installed, or on order, in the United States. The maximum water quantity for each unit is about 16,000 cfs. Component parts are of unusual size and involve features of novel design, details of which will be made available at some future time. The head will vary from a minimum of 60 ft to a maximum of 90.5 ft, depending on the total

flow in the river. The minimum head will occur during flood season, due to high tail water.

The new Cabinet Gorge Plant of the Washington Water Power Company has an interesting combination of four Baldwin-Lima-Hamilton hydraulic turbines which is making a fine record in performance. While designed for a normal head of 90 ft with a unit rating of 70,500 hp (50,000 kw) at 120 rpm, the forebay and tail-water levels are frequently such as to provide up to 105-ft head so that the unit output reaches 66,000 kw and the plant capability 250,000 kw for short periods.

This desirable result is secured at minimum first cost and high efficiency over a wide range of load by utilizing three fixed-blade propeller turbines and one adjustable-blade turbine. The required number of fixed-blade turbines, as determined by the plant load, are operated in the region of maximum efficiency to full gate while the adjustable-blade turbine, which has a much flatter efficiency characteristic takes the load changes. In this way high efficiency is maintained over a wide range of plant output.

Each turbine is supplied with power water by an individual 27-ft-diam plate-steel penstock, over 500 ft in length, and embedded in solid rock. Units are started and synchronized without any surging or hunting and the plant operates very smoothly under load. As the plant is connected to a large system, no surge tank is used. All four turbines have similar dimensions and speed, many duplicate parts being used to reduce first cost and to simplify manufacture and installation. However, the adjustable-blade runner turbine is set 6 ft lower than the fixed-blade type, to maintain a similar margin against cavitation.

In addition, shipment is being completed of four 45,000-hp, 75 rpm, 45-ft-head vertical adjustable-blade turbines for the Old Hickory Development of the Corps of Engineers, U. S. Army, for installation on the Cumberland River in Tennessee.

Valves. While the slide gate is widely used under low heads, for shutoff to the entrance of pressure conduits or the outlet of draft tubes, the butterfly valve continues to enjoy great popularity as a stop valve at the entrance to reaction-turbine scroll cases, or for penstock interconnections. The popularity of the butterfly valve is due to its low first cost, ease of operation, low-head loss, and small leakage.

In 1953, the company completed, for export, a series of butterfly valves, 17 ft in diam, for penstock shutoff use. The bodies and disks were split to permit shipment, the shafts were of the short stub type, and the operation was by means of hydraulic cylinders with oil pressure. Leakage by the disk was controlled by radially adjusted sectionalized bronze rings on the disk. These were adjustable from the downstream side so the valve leakage could be regulated from within the downstream conduit when the valve leaf was closed and under pressure.

Valves of this type, though smaller in diameter, are in successful use under heads up to 1000 ft and over.

Research and Development. In 1954, research and development continued in the design of Francis, fixed-blade and movable-blade propeller turbines, to improve efficiencies, extend the range of heads for propeller turbines, explore cavitation phenomena and damage, and determine characteristics of new materials available.

In addition, a new laboratory extension was designed and construction started to facilitate extensive testing of reversible pump-turbines.

The James Leffel & Company

Some of the company's unique and interesting designs and developments are shown in Figs. 3 to 5. Although these show relatively small-capacity turbines, larger-sized units are also made.

Fig. 3 shows one of three vertical-shaft plate-steel spiral-case turbines for the Dos Bocas Plant of the Puerto Rico Water Resources Authority, San Juan, Puerto Rico. Each unit is rated 8300 hp, 160-ft net head, 300 rpm. This is an unusual design in that the casing was completely riveted in sections in the shop.

Fig. 4 shows a runner for a horizontal spiral-cased turbine furnished for Brazil. The unit was rated 300 hp, 301-ft head, 750 rpm. This runner is of interest because of its relatively small water passages.

Fig. 5 shows a turbine for the National Power Corporation of Manila, Philippine Islands, Taloma No. 2A plant. The unit is rated 690 hp, 49-ft head, 450 rpm. This is an

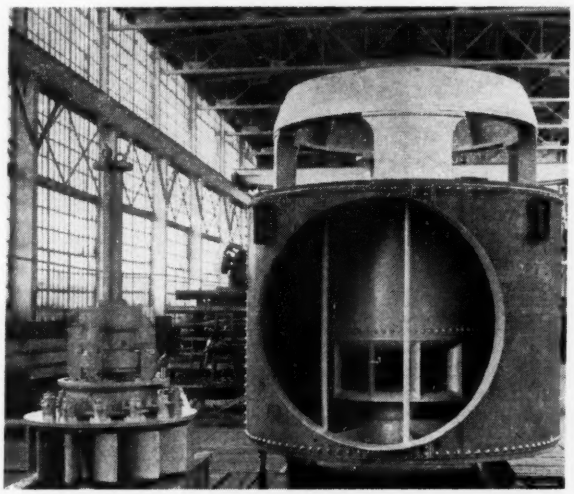


Fig. 3 One of three vertical-shaft plate-steel spiral-case turbines for the Dos Bocas Plant of the Puerto Rico Water Resources Authority

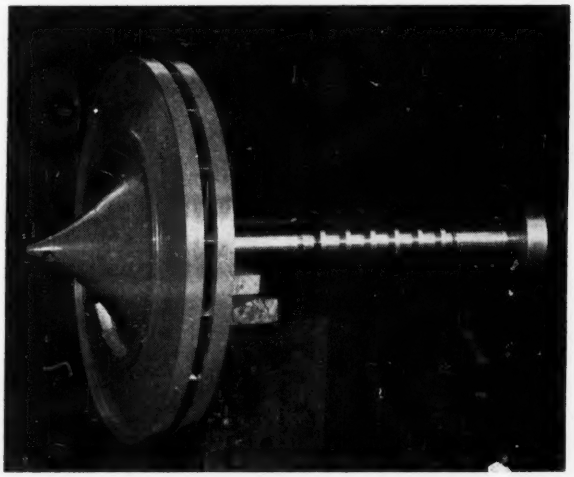


Fig. 4 Runner for a horizontal spiral-cased turbine furnished for Brazil

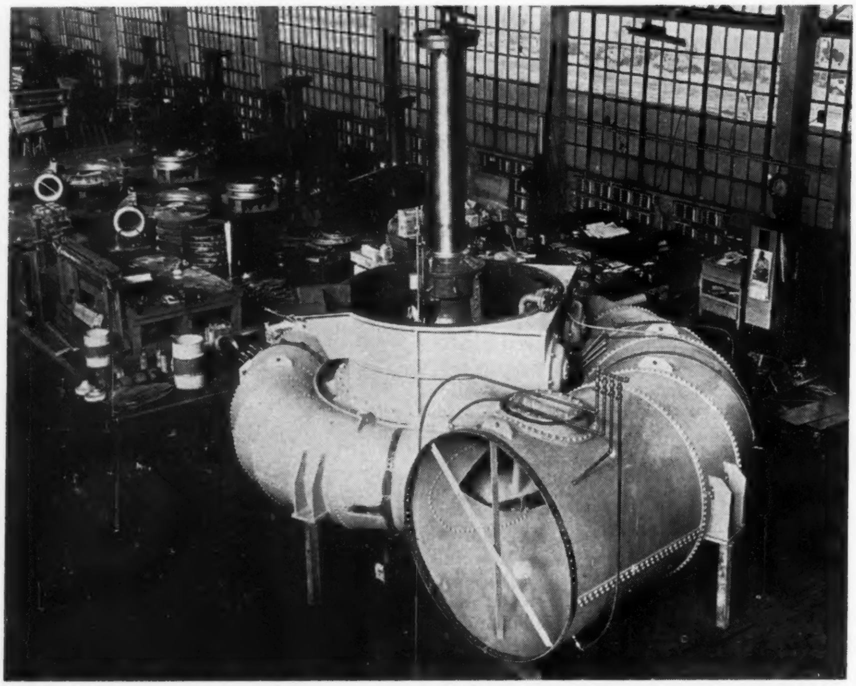


Fig. 5 A 690-hp, 49-ft head, 450-rpm turbine for the National Power Corporation of Manila

unusual design in that the unit is completely self-contained, with a conical plate-steel draft tube and with a cast-iron base for quick and easy mounting and alignment of the generator. This makes a compact design, and is particularly applicable to some of the smaller installations and for replacement in old plants. It saves power-house construction and therefore reduces installation costs.

Newport News Shipbuilding and Dry Dock Company

In order to improve the quality of large cast-steel Francis runners, both for soundness of metal and uniformity of water passages, a satisfactory shop procedure for fabricating such runners from component cast parts has been developed.

The band and crown are cast separately from molds made by a sweep pattern. A bucket pattern is made from wood and used as a template for casting a master pattern of metal. From the master pattern, all buckets are molded. The crown and band are machined separately, giving the water passages a much more uniform and regular surface than is attained by the customary hand-finishing method. The buckets are hand-finished separately.

The band is jigged into position over the crown and each bucket, after being weighed, is lowered into place. Welding edges of the buckets have previously been prepared.

A moderate preheat is used for all welds, and distortion is minimized by a carefully prepared welding sequence. Several stress reliefs of the work are required before completion.

Fig. 6 shows a 15-ft nominal-diameter runner weighing 122,000 lb. An exceptionally well-balanced runner is provided by this method of fabrication.

Fig. 6 A 15-ft nominal-diameter runner weighing 122,000 lb assembled with shaft

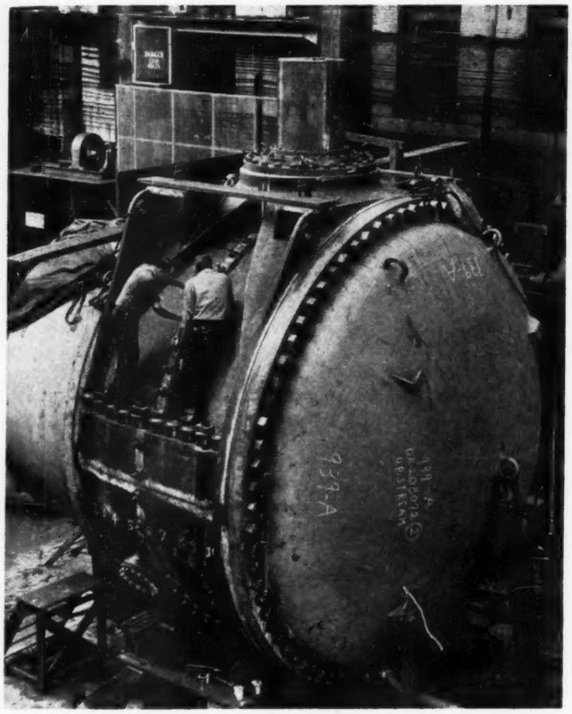


Fig. 7 Shop pressure test of 16-ft high-head butterfly valve

Field tests were recently completed on one of the largest high-head butterfly valves in existence, Fig. 7. The valve disk was of cast steel, in one 16-ft-diam piece, and weighed 92,000 lb. The valve body was in two pieces, 8 ft long between flanges and reduced in cross section, being 16-ft in diam at the entrance and 14 ft, 6 in. in diam at the outlet.

Shop tests under design pressure of 250 psi showed an extremely small amount of leakage due to the adjustable seats fitted into the valve body.

During the field tests the valve was closed against a flow of 3500 cfs. No vibration was discernible and the measured head loss through the valve under this condition was 0.35 ft.

Two additional Kaplan-type hydraulic turbines using antifriction bearings on the blade stems were put into operation in 1953. These units developed 25,000 hp each under a net head of 61 ft.

An inspection was made recently of a comparable adjustable-blade turbine equipped with antifriction bearings which has been in continuous service for 13 years. The bearings were in excellent condition and apparently good for an indefinite period of service.

The Pelton Water Wheel Company

Adjustable-Blade Propeller Turbines. An outstanding installation of this type of turbine for the past few years included twelve 1600-hp 40-ft-head, 242-rpm, 6-blade units in the Portland General Electric Company's Station "B." These turbines were built for manual adjustment of the blade angle by a mechanism extending to the main shaft coupling. The blades were of cast Ampco metal.

The installation is distinguished by the fact that the runner center line is located 23 ft above minimum tail water.

Low-Head Reaction Turbines. A recent installation represents three 52,500-hp, 165-ft-head, 128.6-rpm Francis turbines for the U. S. Army Engineers Lookout Point Development.

The interesting feature of this installation is the 85,000-lb turbine runner which is of welded construction.

The 13 individual buckets and the crown and band were made up as separate castings, magnaflux-inspected and repair-welded, finish-ground, and thereafter welded into a single assembly.

It is believed that this is the largest welded Francis runner produced in the United States to date. See Fig. 8.

High-Head Reaction Turbines. Pelton's most notable installations in the high-head reaction category consist of two 48,000-hp 514-rpm turbines under an operating head of 1055 ft for the Flatiron Plant of the U. S. Bureau of Reclamation. It is believed this is the highest-head Francis turbine now operating on this continent.

The guaranteed maximum efficiency was 90 per cent at 39,000 hp, and Gibson Test Reports indicate an actual maximum efficiency of 90.5 per cent.

Impulse Turbines. The company's most important impulse turbine is a 140,000-hp, 2500-ft head, 327-rpm, 4-nozzle vertical unit for the Kemano Development of the Aluminum Company of Canada.

The wheel is made up of twenty-two 1450-lb mild-steel buckets individually bolted to a forged-steel disk.

The guaranteed maximum efficiency is 90 per cent at 110,000 hp.

Dynamic Balancer. With a newly developed dynamic balancer it will be possible to increase the smoothness of operation of large hydraulic-turbine rotating elements without requiring the services of the large and expensive

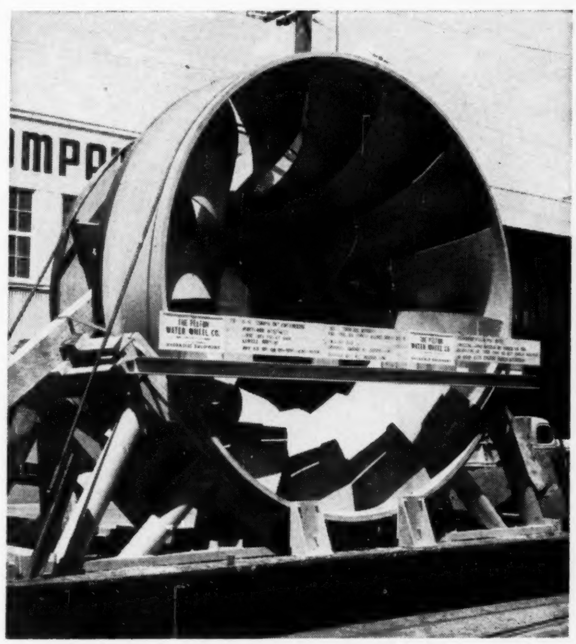


Fig. 8 A 162-in-OD Francis runner—52,500 hp, 185-ft head, 128.6 rpm, for Corps of Engineers, U.S.A., Lookout Point Powerhouse Unit No. 2

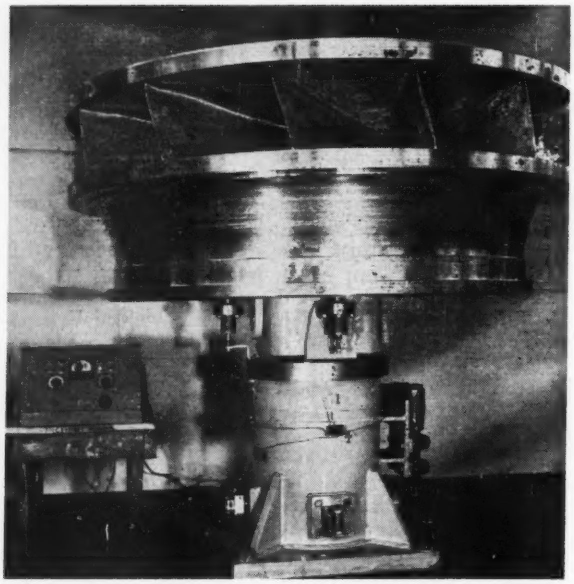


Fig. 9 Stainless-steel reaction runner on Pelton dynamic balancer. The balancer is handling an 8000-lb Francis runner. Pelton balancers have been made to cover a weight range of 100 to 250,000 lb.

mandrels which must be used with conventional balancing machines.

The Pelton balancer utilizes a large universal joint positioned near the center of gravity of the wheel or runner and restrained by a spring assembly. Strain gages are used for measuring force indication. Balancers have been made to cover a weight range of 100 to 250,000 lb. As an example, an 85,000-lb runner can be balanced easily to within a static/dynamic couple of less than 18.5 lb per sq ft in a few hours. Fig. 9 shows a balancer handling an 8000-lb Francis runner.

Hydraulic Laboratories Remote From Plant-Testing Laboratory. A "Mountain Laboratory" is located in the Big Creek No. 1 plant of the Southern California Edison Company where a head of 1900 ft is available. The equipment consists of a 300-hp geared turbine-generator in which the turbine is operated at 3300 rpm to permit obtaining accelerated life tests on a wide range of impulse bucket materials.

Another component of the laboratory setup is a field installation involving a 532-hp impulse turbine operating under a maximum head of 2600 ft at 1200 rpm. Buckets of a wide range of materials are tested under commercial operating conditions as part of a long-range program to obtain better bucket life.

Hydraulic-Turbine Governors and Actuators. During the past few years Pelton has aggressively re-entered into the manufacture of hydraulic-turbine governors and actua-

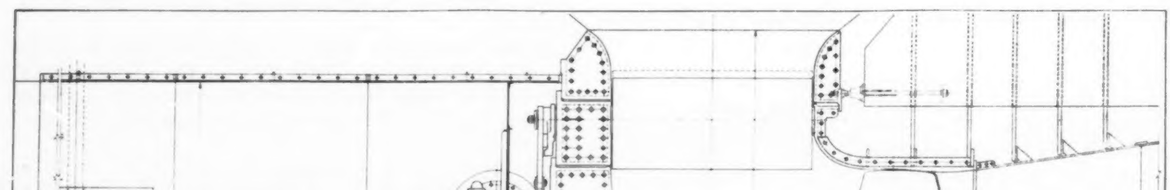


Fig. 10 Cross-sectional diagram through a Kaplan turbine for the McNary Project rated at 111,300 hp under 80-ft head

tors. To date, 36 new units have been installed which control a turbine output of 558,000 hp and supply a governor effort of 2,076,350 ft-lb of energy. As of last June, governors operating, or on order, total 66, with a total turbine capacity representing 2,825,350 hp and a total governor effort of 27,411,800 ft-lb of energy.

Pelton governors have proved to be capable of meeting the maximum of sensitivity requirements and are designed adaptable for any type of automatic control for use with all turbine types.

For example, a 186,000 ft-lb actuator was recently installed for the Bridge River Power House of the B.C. Electric Company.

S. Morgan Smith Company

Kaplan Turbines. During the past two years nine units of the U. S. Corps of Engineers McNary Project have been put into operation. The powerhouse will contain 14 units when completed early in 1956. Rated 111,300 hp under 80-ft head, the units are the most powerful Kaplan turbines in operation anywhere. During tests an output of 138,000 hp under 89-ft head was developed. See Fig. 10.

The first Kaplan units purchased by the U. S. Bureau of Reclamation were put into service in June, 1955. The two units are rated 9400 hp each under 41.5-ft head and are installed at the Nimbus Dam.

A Kaplan runner for Central Maine Power Company was developed with roller-type trunnion bearings and is now ready for installation and testing.

A special automatic machine was developed to produce an improved stainless weld overlay on areas subject to cavitation of medium and large Kaplan blades. Reduced penetration of the deposited metal minimizes dilution of the nickel and chrome elements with the base material.

Francis Turbines. In process of manufacture and installation are six units for Chief Joseph Dam, U. S. Corps of Engineers, each rated 100,000 hp under 165-ft head; four units for U. S. Bureau of Reclamation Palisades Project each rated 39,500 hp at 190-ft head; and four units for Connecticut River Power Company, Littleton Development of 56,400 hp at 150-ft head.

Design. Increasing use of weld fabrication is being made for the various turbine parts. Individual components for such fabrication consist of plates and structural shapes, cast steel, and forgings. Assembly by welding of cast-steel components of large structures such as Francis runners, Fig. 11, stay rings, etc., results in greater reliability and facilitates molding and casting.

Research. As an extension to the present hydraulic laboratory a new stand was put into operation to permit performance and cavitation testing up to 300-ft heads.

Accessories. Two 18-ft-diam butterfly valves completely weld-fabricated with adjustable seats at the disk edge and two-cylinder oil hydraulic operators were installed at Blakely Mountain, a U. S. Corps of Engineers project. The maximum head on the valve including pressure rise is 253 ft.

Rotovalves, which are conical plug-type double-seated valves, are being used on an increasing scale as turbine-inlet valves. Sizes up to 84 in. diam have been furnished.

Double-seated spherical valves for high-head turbines allowing servicing of downstream seat without unwatering manifold are in process of installation.

Fig. 11 Typical example of assembly by welding is this large Francis runner

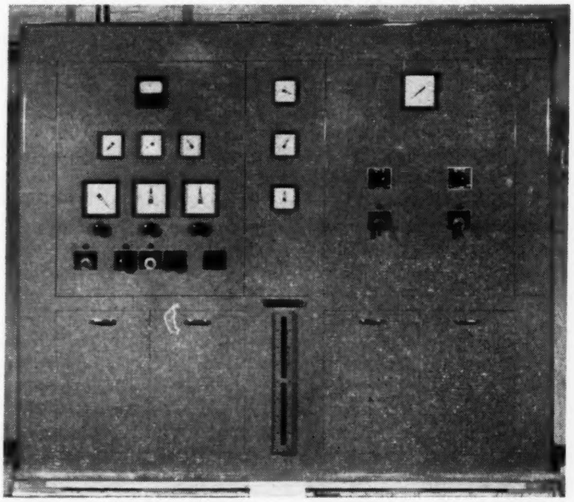


Fig. 12 Exterior view of cabinet-type actuator for impulse-turbine control

Applications of bascule gates are increasing. Their inherent advantages are adaptability to existing dam structures, ease of controlling levels, and passing of debris and ice.

Several Howell-Bunger valves have given good service as pressure regulators at the Toketee Plant of the California-Oregon Power Company. This type valve designed for free discharge service has been furnished in sizes up to 96 in. diam for by-passing of water.

Woodward Governor Company

Cabinet-Type Actuator for Impulse-Turbine Control. This design, developed by Woodward Governor, incorporates in a single housing all of the pumping and control

equipment required to regulate a multijet impulse turbine.

The actuator base serves as the governor oil sump tank, with the oil pumps and deflector, as well as needle position controls, installed on top of this. All of the mechanism is housed within a cabinet and the front of this serves as a panel for the various required indicators and manual-control facilities.

Fig. 12 shows the exterior of the actuator and the control panels.

Fig. 13 shows, schematically, how the control is arranged, and it will be noted that movement of the deflector distributing valve, as a result of a change in unit speed, is accompanied by a simultaneous movement of the needles. This has the effect of reducing the time lag in the over-all control system to a minimum.

A cam is provided which acts to establish the proper deflector-needle relationship for steady-state load conditions.

Fig 13 also shows a solenoid control which can be actuated to cause the needles to be opened. The unit speed is then entirely under control of the deflectors. This allows a large block of load to be thrown on the unit suddenly, with a small drop in frequency. Without this feature, the speed drop would be substantially greater, due to the necessarily slow rate of opening of the needles.

Two such governors are in operation at the Kemano Plant of the Aluminum Company of Canada, and a third governor for this plant is in the process of manufacture. The turbines are four-jet vertical-shaft machines, rated at 140,000 hp each.

In addition, four governors of similar design have been provided for installation at the Cubatao Plant of the Sao Paulo Tramway Light and Power Company, Ltd., in Brazil. These turbines are also four-jet machines, rated at 88,000 hp each.

Solenoid-Actuated Auxiliary Dashpot By-Pass. Fig. 14 shows a revised design of compensating dashpot, which provides for increased flexibility of operation. This

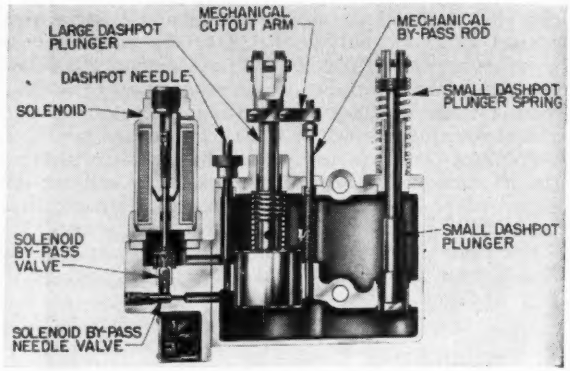


Fig. 14 Revised design of compensating dashpot which provides for increased flexibility of operation

incorporates a solenoid which may be electrically actuated for the purpose of reducing the damping effect of the dashpot.

In order to obtain stability at no load, it is often necessary to adjust the needle valve to give greater damping than is necessary under other operating conditions.

This can result in requiring an excessively long time to return to speed following a disturbance, or to establish a revised gate position following an impulse from the load and frequency control equipment.

The auxiliary needle can be adjusted easily to give the performance desired and if at any time the reduced damping effect is no longer desired, the solenoid can be de-energized, and control as determined by the needle-valve setting is re-established.

Now furnished as standard equipment with all Woodward cabinet-type actuators, this modified design can be provided for all Woodward governors furnished in the past.

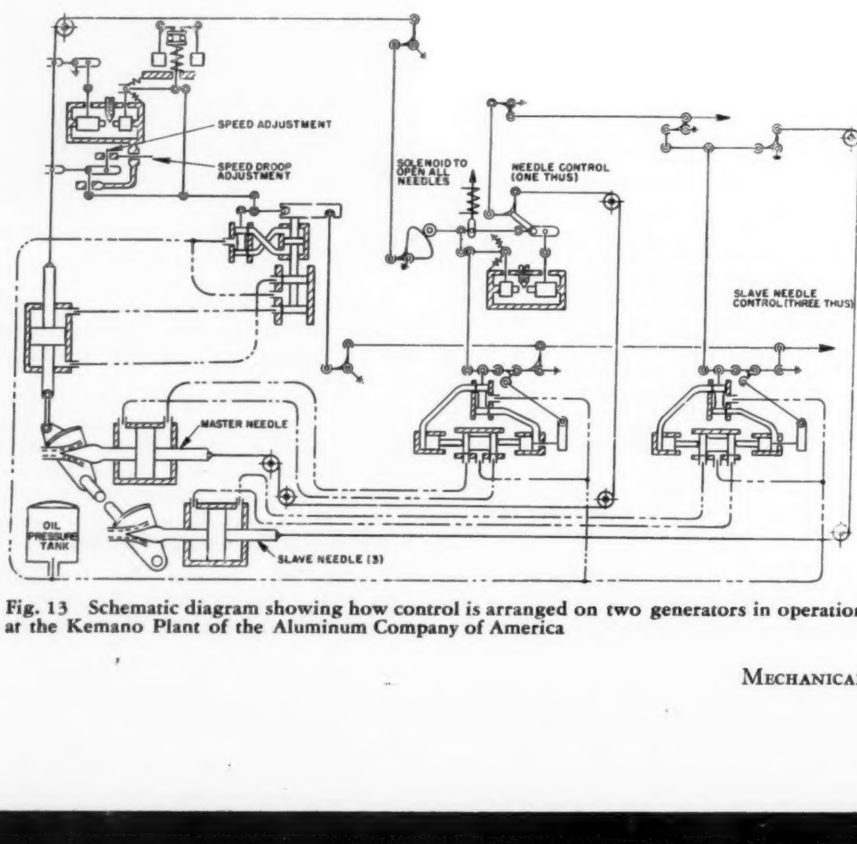


Fig. 13 Schematic diagram showing how control is arranged on two generators in operation at the Kemano Plant of the Aluminum Company of America

Research-Based Industries In New England

By Richard M. Alt

Arthur D. Little, Inc.,
Cambridge, Mass.

It has often been said that research provides a strong base for industrial growth in New England. The belief that research will be important to New England's industrial future led the Federal Reserve Bank of Boston, three years ago, to engage Arthur D. Little, Inc., to survey industrial opportunities in New England arising from advances in technology. A large number of industrial opportunities were identified, many of them related to research. An appreciation of the influence of research on industrial growth in New England may be gained by considering three points:

1 The relationship between research and industrial growth;

2 New England's research base;

3 The growth of research-based industry in New England.

Relationship Between Research and Industrial Growth

Most research conducted by industry is consciously oriented to early practical applications. It is *applied*, not *pure*, research. The recent Harvard study, "Spending for Industrial Research," showed that in 191 large companies 42 per cent of their research and development funds went toward the creation of new products or processes, about 50 per cent to improvement of existing products or processes, and only 8 per cent to "programs uncommitted to specific problems."

Total expenditures in the U. S. on research rose from around $65 million in 1920 to $4 billion in 1953. In 1941 there were 87,000 scientists and engineers employed in research and development activities; by 1953 there were 192,000. Since it is estimated that 1.5 supporting workers are required for each professional worker, this means a total of more than half a million workers in research. What is the relationship of this increasing research effort to industrial growth? As a matter of reference, while research expenditures increased 61 times from 1920 to 1953, gross national product increased 6 times. Of course this comparison does not necessarily indicate a causal relationship. A better understanding of the influence of research on industrial growth can be obtained by comparing research expenditures by industry with growth in employment in these industries. The Bureau of Labor Statistics' study "Scientific Research and Development in American Industry" shows that aircraft, electrical machinery, and instruments were the highest in research expenditures. Drugs and industrial organic chemicals were also high. These were also among the fastest-growing industries as shown by employment increases in the period 1947–1953. On the other hand, some industries such as primary metals, fabricated metal products, and paper grew rapidly but spent little on research. It can be pointed out, however, that the slow-growing or declining industries, such as food processing and textiles, spent little on research. By and large, the growing industries spent the most on research.

New England's Research Base

New England's research base consists of its research institutions and its supply of professional, scientific, and engineering personnel. Eleven per cent of the nation's industrial laboratories are found in New England, and employ about 9 per cent of the total research personnel of the United States. Approximately 10 per cent of total manufacturing employment for the country is found in New England. It has few large industrial laboratories, only one—United Aircraft—having over 500 professional employees. New England manufacturers hold a relatively small proportion of government research contracts, this situation resulting in part from the small size of many New England firms. Many industries in New England—including some of the growth industries such as fabricated metal products—do less than their normal share of research when compared with their share of total U. S. employment in their industries. This has led the Committee of New England to conclude that: "New England's *industrial* research and development efforts are a little below the United States standard."[1]

None of the trade-association laboratories is located in New England, although undoubtedly New England member companies support this research. There are only two industry-sponsored research foundations in the region, the Pulp and Paper Foundation at the University of Maine, and the Northeastern Wood Utilization Council. Similarly, there is only one nonprofit research foundation, the Lowell Technological Institute Research Foundation for textile research.

The U. S. Government in the past has operated few laboratories in the region. Not one of the 60 laboratories operated by the Department of Agriculture, Bureau of

Based on an address presented at the Machine Design Luncheon during the Diamond Jubilee Semi-Annual Meeting, June 19–24, 1955, of The American Society of Mechanical Engineers.

[1] The Economic State of New England, p. 566.

Research Outlays and Employment Expansion in Selected Industries

Industry	Research Cost (% of Sales, 1951)	Employment Increase (1947–1953) U. S.	Employment Increase (1947–1953) N. E.
Aircraft	12.7	257	172
Electrical machinery	6.4	38	39
Instruments	5.8	28	13
Drugs	3.3	6	16
Industrial organic chemicals	3.0	43	137
Machinery	1.5	10	−0.8
Stone, clay, glass	1.3	8	7
Automobile	1.2	12	90
Paint	1.1	7	4
Rubber products	0.9	7	−0.9
Metal products	0.9	18	10
Textiles	0.9	−10	−24
Petroleum refining	0.6	8	0
Paper	0.5	17	3
Primary metals	0.4	123	−6
Food	0.3	−2	−8
Apparel		6	10
Lumber		−7	−11
Leather		−9	−5
Furniture		8	18

Source: U. S. Bureau of Labor Statistics.

Standards, and Bureau of Mines, is located in the region. On the other hand, the Watertown Arsenal has done important work in stimulating industrial use of titanium, and the Quartermaster Laboratory in Natick and the Air Force Electronics Laboratory in Bedford employ substantial numbers of professional workers.

New England's research base has been strengthened by the growth of independent consulting laboratories. There are 462 in all, including the country's largest one. They employ 12.7 per cent of the country's professional research personnel.

Finally, we come to the universities, the major stars in New England's research constellation. It is interesting to note that 92 of the 435 members of the National Academy of Science are from New England. In 1950 New England institutions held 29 per cent of the value of research and development contracts placed with educational institutions.

It is difficult to arrive at an over-all evaluation of New England's research institutions. Perhaps we could say that, while the research strength in universities and independent consulting laboratories is above average, research in some other quarters lags behind the country as a whole. The Committee of New England concluded: "On balance, New England seems as active in its total technical effort as the nation as a whole."

Now let us look at New England's research manpower. In 1948 the U. S. Bureau of Labor Statistics conducted a survey of 41,000 American scientists. Fourteen per cent of the PhD degrees and 12.5 per cent of their bachelor's degrees were awarded in New England. (It must be remembered that only 6.3 per cent of the U. S. population resides here.) Of the 41,000 scientists only 8.1 per cent were employed in New England. Thus there is an outflow of New England-trained scientists to other parts of the country, which is natural since many students come to New England from other states and from foreign countries, to which they often return.

What of those who remain? A salary survey by the Bureau of Labor Statistics in 1948 indicated that they are less well paid than those in other regions. The median salary of PhD scientists employed by private industry in that year was lower than that in any other region except the Mountain and Plain states.[2] Evidently the deficiency is made up by what economists like to call "psychic income" for those who remain in New England. Whatever the inducement, it is obvious that regional factors—educational, cultural, recreational, climatic—enter job calculations. Of course it must be acknowledged that New England is not the only region that appeals to scientists and engineers.

The economic significance of the foregoing is interesting. Here we have what may be a major regional resource available to industrial companies at lower cost than elsewhere. Economically, the availability of low-cost research for the research-using industries might be compared with the availability in some other areas of low-cost power for the heavy power-consuming industries. This is certainly one of the aspects of New England's research base which is definitely favorable to the establishment of industry.

Growth of Research-Based Industry in New England

At this point it is necessary to make a distinction between industries which are research-using and those which are research-based. Research-using industries are simply those which spend substantial amounts on research. Research-based industries, however, are those in which production operations are attracted to the region in which research resources are available.

Research-Using Industry. In several cases the research-using industries have grown faster in New England than they have elsewhere in the United States. Of the five top research-using industries, three have grown more rapidly in New England than elsewhere in the period 1947 to 1953. These are electrical machinery (chiefly electronics), drugs, and industrial organic chemicals. The aircraft and instrument industries have grown more rapidly in other parts of the United States, chiefly because of locational requirements of defense industry. But it should be noted that these industries also have had vigorous growth in New England.

Not all *research-using industry*, however, is *research-based*. In some of the research-using industries, research may not be a dominant locational factor. Raw materials, as in the petrochemicals industry, may dictate the choice of location, and research workers, being mobile, may be brought from a distance—at higher salaries if necessary. In other industries, especially where firms are large, research may take place in one area and production in another. Plants may be located where production costs can be minimized or where markets can be most effectively served. Where research operations can be separated from production, the locational determinants of research laboratories may be quite different than those for production facilities. This is seen in the case of the recently established RCA laboratories in Waltham.

Research-Based Industry. There are two types of research-based industry in New England: (1) Laboratories and plants of large companies which have part or all of their operations closely integrated with research; (2) new, small companies making highly technical products.

Large Research-Based Companies. Units of large companies can be research-based, and an increasing number

[2] U. S. Bureau of Labor Statistics, "Employment, Education, and Earnings of American Men of Science," Bulletin No. 1027, Washington, D. C., 1951.

of these find New England locations desirable. These companies are especially numerous in the electronics industry. Raytheon, for example, is one of our largest research-based companies, employing more than 1500 engineers and scientists. The available supply of these professional workers is an important factor in Raytheon's location, but other characteristics of the New England economy reinforce this advantage. A large and dependable labor force and the existence of many small firms who work on subcontracts are also factors in making a New England location desirable for an electronics manufacturer. At the same time, it is interesting to note that in the larger mass-production items such as radios and TV sets, Raytheon uses a Midwestern, market-oriented plant near Chicago.

United Aircraft in Hartford is another example of large, research-based enterprise. Much of United's research and development work is carried on in Hartford, although, for reasons of climate and dispersal, the Chance-Vought Division was moved to Dallas several years ago. United is an especially good example of research-based industry because its research men must be in intimate contact with the constantly changing development aspects of production operations. Of course United, like Raytheon, finds other advantages in a New England location: a network of smaller firms as subcontractors, and a skilled labor supply.

New, Small Companies. A second type of research-based industry is the numerous group of new, small companies making highly technical products. There are three ingredients in the success of these companies: Men, ideas, and money.

Unlike large research-based industry, the strongest link between the New England research base and the company is likely to be in the persons of owner-managers of these companies. Many of these owner-managers have had very close ties with New England universities, especially M.I.T., and have established companies such as Tracerlab, Polaroid, and National Research, for the production of highly technical products which they, as research men, have invented and developed. Many of these products are in the field of electronics but they are also in instruments, chemicals, nonelectrical machinery, plastics, fabricated metal products, food processing, and leather products. These industries are research-based not only because their location in New England was determined by the situs of their research-trained management but because of their continuing intimate connection with university research circles and their need to recruit research personnel from the universities. By these tests New England is obviously a good place for this type of industry.

The second ingredient in the growth of these firms is *ideas*. One method of selecting the idea is to observe an unanswered market need. Then, if research can solve the problem, the new firm can place a product on the market which will obtain sales needed for business success.

Ideas for research-based companies also come from other sources. Sometimes the market does not understand the significance or application of basic research being carried on in universities. And the scientists themselves who are engaged in research may not appreciate its useful application; they are engaged in improving theoretical understanding of a field. Thus there is need for a new company to undertake the commercial development of basic research. An example is

Looking to the future, it seems highly probable that the amount of research used in industrial applications will increase substantially in the next few decades. Research skills will be in even higher demand, and there will be a strong tendency on the part of industrial companies to establish some of their operations in regions like New England that offer excellent research facilities and research personnel. This will probably result in the further upgrading of employment in New England and similar areas—more jobs being offered for more highly trained men. Favorable to New England is the demonstrated ability of her people to create new products and new processes. This is the important fact underlying research-based industry in New England.

the High Voltage Engineering Corporation, which was founded to manufacture the electrostatic generator invented by the physicist Dr. Robert Van de Graaff of M.I.T. The machine is now generally used in the treatment of cancer and in many other applications such as industrial radiography, nuclear research, and the sterilization of foods and drugs.

Sometimes the idea which sparks a research-based company comes from the chance to participate in the growth of a new field. As research in nuclear physics was extended into industrial fields, there arose a need for improved instruments. The opportunity to manufacture these instruments led a group of young scientists to form Tracerlab, Inc., which has in less than a decade attained a leading position in the development and sale of instruments employing radioactive isotopes.

Some research-based companies have been formed to manufacture products based on new patents. An example is Photon, Inc., which manufactures equipment that utilizes photography in printing. The development of the patented ideas underlying the process was done by a nonprofit foundation, the Graphic Arts Research Foundation, supported generally by the printing industry.

The third ingredient for the success of research-based industry is *money*. New England has unusual financial resources for assisting new research-based industry. Located in Boston are private-venture capital groups such as American Research and Development Corporation, which has unique ways of assisting new industry. A.R.D.'s portfolio, for example, shows holdings in such New England research-based companies as High Voltage Engineering, Tracerlab, Baird Associates, Snyder Chemical, Flexible Tubing Corporation, Secotan, Ionics, Inc., Control Engineering, and American Polymer.

In five of the New England states there are also privately owned business-development corporations, which supply risk funds that would not ordinarily be available through banking channels. The Massachusetts Business Development Corporation in 1954 made financial commitments of almost $4 million to 32 companies, representing an annual payroll in excess of $12 million. In many instances the resources of this corporation have been made available to research-based industries.

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Associate Editor*

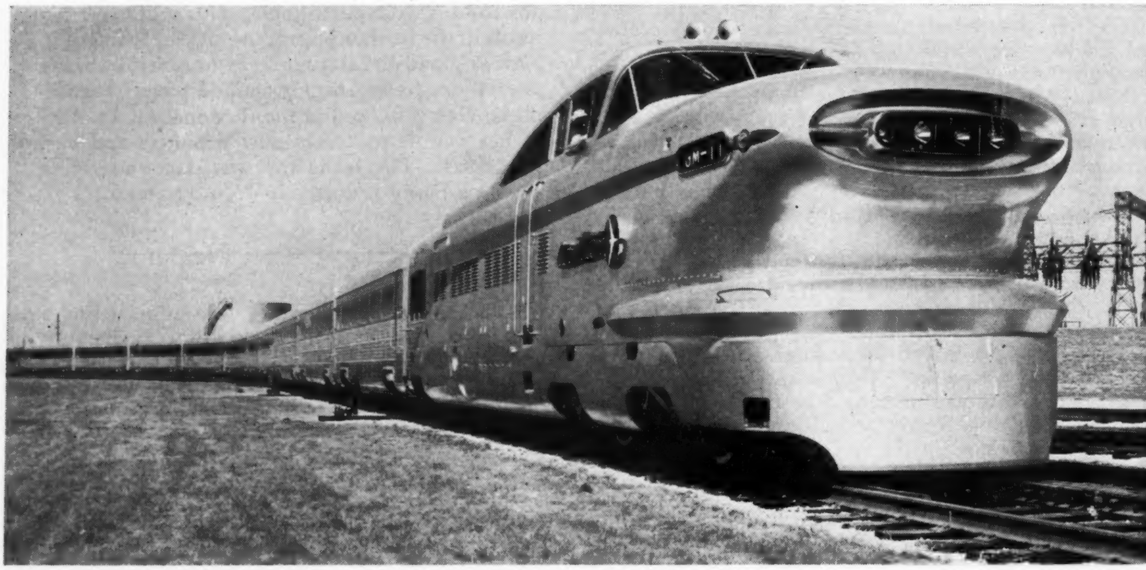


Fig. 1 General Motor's new "Aerotrain," first American-built complete lightweight passenger train, was a major attraction of the General Motors Powerama on Chicago's lakefront near Soldier Field, Aug. 31 to Sept. 25, 1955. The ten-coach, 400-passenger train weighs 50 per cent less than conventional trains. Top speed of the locomotive is 102 mph.

Lightweight Train

An experimental lightweight train, designed to reduce train weight by more than 50 per cent, train investment by almost 60 per cent, and train maintenance and operating expense by nearly 60 per cent, excluding crew costs, has been developed and built by General Motors Electro-Motive Division of La Grange, Ill.

The new 10-coach Aerotrain with a seating capacity of 400 will be hauled by a one-unit 1200-hp diesel locomotive. It is expected to provide the railroads with a tool "to help wipe out the annual passenger-train deficit of over $700,000,000," according to N. C. Dezendorf, vice-president of General Motors and general manager of Electro-Motive.

"At the same time, its improved riding qualities—passengers literally ride on air—will permit higher sustained speeds with comfort to the passengers which should permit better schedules to attract more passenger revenue," he said. "Whether or not these results can be accomplished will have to be proved by exhaustive tests."

The Aerotrain was introduced to the public at the General Motors Powerama held in Chicago, Ill., Aug. 31 to Sept. 25, 1955.

The locomotive contains a standard General Motors diesel engine and Electro-Motive generators, traction motors, and control apparatus. Car design has been based on an adaptation of the present body of the GMC Truck and Coach Division's 40-passenger intercity-type highway coach; the air conditioning is from Frigidaire Division; the auxiliary diesel engines for train heat and air conditioning from Detroit Diesel Engine Division; and the auxiliary generators from Delco Products Division.

Coach Design

In the design of the coaches, Electro-Motive designers have evolved a new type of car in which the body is so low in first cost that in comparison with present railroad-passenger cars it can be regarded as expendable. The steel undercarriage of the car is made with unusual stamina to last for many years and with no emphasis on styling. Consequently, it will need relatively little attention. The aluminum car bodies, in contrast, while far exceeding the governmental and AAR requirements for safety, are so low in first cost that they can be thrown away and replaced new when they reach the condition requiring overhaul, for much less money than the railroads now spend for repairing and refurbishing present cars, it is believed. This practice will have the added advantage that all advances in the art of coach building that have accumulated since the previous body was put

on the undercarriage can be incorporated in the train in the new bodies. In essence this gives the railroads opportunity to come out with distinctly new styling and new comfort and safety features on a train without added expenditure approximately every seven years, which is the present average life of a railroad coach between complete overhauls.

The 40-passenger GMC coach body has been widened 18 in. to give more comfortable seating space and a wider aisle in the new-type railroad coach. The driver and engine compartments are replaced by vestibules. One car end contains a lavatory and pantry for serving meals. The other end is a vestibule with entrances on both sides. The doors and steps are so arranged that the entrances will serve either high or low station platforms. The whole body is mounted on a four-wheel underframe capable of meeting all railroad operating necessities. The car will meet all governmental and AAR safety requirements by a wide margin. In the matter of impact strength, for instance, it will withstand 800,000-lb buff whereas regulations require only 400,000 lb for a train of this weight.

The suspension is completely air-ride with many of the members interchangeable with standard GMC intercity bus construction. The whole new concept of riding comfort includes self-compensation around curves giving a ride in which the axle and the car floor are parallel and eliminating through-metal impacts. The passenger literally rides on air.

The baggage compartment is under the floor as in modern buses and the passengers will ride at a level higher than in other lightweight trains to provide a more enjoyable view of scenery. Despite this, the center of gravity of the cars is exceptionally low—45 in. above rail compared with 55 in. in the present standard railroad coach.

The cars are nonarticulated. They are more readily assembled into a train than present cars because all connections are automatically coupled when the cars are brought together.

Two of these 40-passenger cars are equivalent to one 80-passenger conventional railroad coach. Two GM cars will weigh approximately 30 tons as compared with 65 tons for the conventional car. When tooled for volume production it is expected that the new car could be sold for $900 to $1000 per seat, compared with $2250 average cost per seat of the present newest coaches. The cars are 40 ft long, 10 ft 9 in. in height above rail, and 9 ft 6 in. in width.

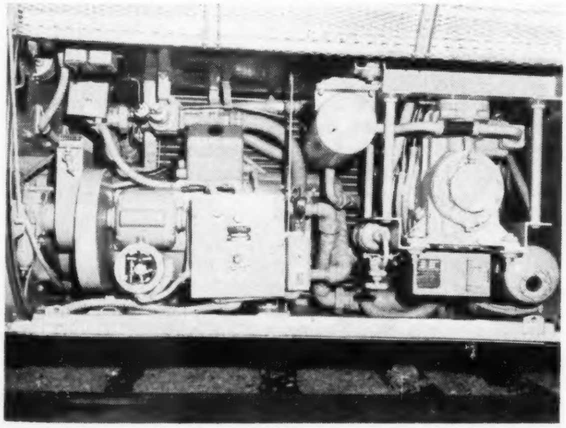


Fig. 2 Compact heating and air-conditioning unit in each car of the Aerotrain is placed beneath seat level, adjoining extra luggage compartments, thus giving passengers a "high-level" ride for better view of passing scenery

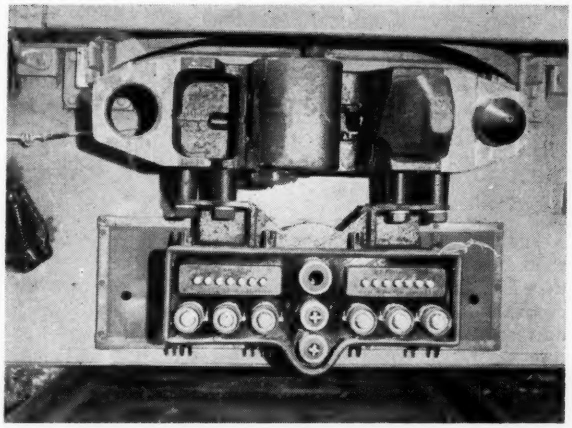


Fig. 3 The Aerotrain uses a new automatic coupling device, which in one operation, as it couples, does what previously required several operations. It is no longer necessary for trainmen to crawl between cars and make the several couplings.

Diesel Locomotive

The locomotive, which is 53 ft long and 13 ft 7 in. above rail in height, is powered by one 12-567C General Motors diesel engine with 1200 hp for traction. The front four-wheel truck is the driving truck with two traction motors. There is an idler axle with two wheels to sustain weight at the rear of the locomotive. Two General Motors 6-71 Detroit diesel engines in the locomotive operate Delco generators which supply current for the train heating, lighting, and air conditioning.

The locomotive has the dynamic brake, which gives the train the economy of electric braking for controlling speed on long grades. The locomotive is geared for a top speed of 102 mph. The low center of gravity and the lightweight of the train permit much faster average speeds than attained by present equipment.

The new locomotive consumes approximately 1.3 gal of fuel oil per mile at top speed with full load in level country. At the present price of fuel oil delivered to a train in Chicago this means that 400 persons could be hauled from Chicago to New York for approximately $125 worth of fuel, or about 32 cents per passenger. To duplicate this performance with present passenger coaches would require two of the same 1200-hp diesels in GM's E9 high-speed passenger locomotive.

Mines Bureau Research

Funds totaling $18,863,000, just made available to the Bureau of Mines for the fiscal year 1956, will enable that agency to embark on new research programs and to continue its long-range tasks of promoting efficiency, economy, and safety in the mineral and allied industries, according to the Department of the Interior.

Of the total appropriation, the Bureau will use $6,603,-870 for its programs on solid, liquid, and gaseous fuels, $300,000 for controlling fires in inactive coal deposits, $5,989,130 for studies on metallic and nonmetallic minerals, $5,000,000 for its health, safety, and coal-mine-inspection programs, and $970,000 for general administrative expenses.

Coal Studies

The new appropriation likewise will enable the Bureau to intensify efforts to learn the nature of, and develop uses for, tars produced during the low-temperature carbonization of coal. This work, together with stepped-up research on coal gasification, will permit more effective operation of the new Appalachian Experiment Station at Morgantown, W. Va.

In addition, experiments on gasifying unmined coal underground will be resumed at Gorgas, Ala., in co-operation with industry. A new method of opening passages in the coal bed will be studied.

Work on both surface and underground gasification is especially important, because production of synthesis gas (carbon monoxide plus hydrogen), hydrogen, or synthetic methane is the major cost factor in making synthetic liquid fuels or high Btu pipe-line gas from coal.

Other studies on coal will proceed on the present scale, as will those on petroleum and natural gas. In this connection some of the Bureau's coal research and a substantial part of its oil and gas research are financed by co-operating private organizations and by other Government agencies.

Petroleum Research

Research to be conducted on petroleum production, including secondary recovery, will provide data that will aid in the most efficient use of the potential energy of oil and gas mixtures in underground reservoir rocks to achieve maximum yield, foster the application of pressure-maintenance in fields where this is practicable to increase recovery of petroleum further, and promote the use of improved secondary recovery methods in old stripper fields. This work will continue at about the same level as in fiscal year 1955.

During the year the Bureau will continue its program of obtaining accurate values for the thermodynamic properties of hydrocarbons and related substances found in petroleum, and for the chemical compounds that may be manufactured from petroleum components. This information enables industry to develop more efficient methods for operations that involve chemical changes.

The Bureau also will intensify studies on the fundamental causes for deterioration of gasoline and distillate fuel oils in storage, one of the perplexing problems confronting manufacturers and users of these fuels. Facets of this problem to be attacked during the year include factors that promote instability, the effect of controlled oxidation, the types of products formed, the chemical substances that result in instability, and characteristics of the deterioration products.

Helium

The appropriation for research on helium, of which the Bureau is the sole large-scale producer, is $90,000, the same as for the 1955 fiscal year. This work is designed to locate new sources of helium-bearing natural gas and to develop more efficient methods for extracting helium from present sources. Actual production of helium will be financed, as in previous years, out of a revolving fund derived from sales of this inert, lightweight gas to Federal and non-Federal purchasers.

Utilizing facilities at the new Rare and Precious Metals Experiment Station at Reno, Nev., the Bureau plans to increase efforts to separate the rare earth metals such as cerium, lanthanum, and neodymium, and to determine their properties and potential uses. Research has shown the rare earth metals to have potentially great value as alloying materials in the steel and light-metals industries. It also will devote more study to the metallurgy of thorium, the most important radioactive metal other than uranium, which is associated with the rare earth metals in monazite deposits.

Another urgently needed undertaking that the appropriation will make possible is a study of modern ore-mining methods. Developments in recent years have made the classic references on mining obsolete, and there is need for compiling data on methods and costs that will assist the industry in coping with today's problems. Information on the results achieved with new methods and equipment will be collected and made available to industry.

Mining and Metallurgical Research

The Bureau will continue its long-range program of mining and metallurgical research, and investigations directed toward more effective exploitation of mineral resources and the eventual commercial development of domestic mineral deposits now marginal or submarginal. Studies of the basic mechanics of block caving will be stepped up, with the purpose of making this lowest-cost underground-mining method more widely and uniformly applicable.

Important elements of the program are related to such ferroalloy materials as manganese, tungsten, molybdenum, and vanadium; the utilization of low-grade domestic materials as substitutes for imported bauxite in aluminum production; study of the alloys of magnesium, and improved methods for producing ductile titanium and zirconium. Long-range studies are to start at a copper property to develop mining methods that will make it possible to mine a much larger proportion of the ore than can be recovered by methods currently used.

Recovery of metals from scrap and other discarded products and as by-products of certain processes is of growing importance as the relative quantity of scrap compared to primary metal production increases. The Bureau is giving increasing attention as a long-range effort to improved and new methods for recovering greater amounts of metals in purer and more useful forms.

Among problems in the field of nonmetallic minerals, the Bureau will seek ways for reducing the nation's dependence upon imports of such materials as asbestos, mica, and industrial diamonds. This will involve search for methods of utilizing low-grade domestic deposits and efforts to develop or synthesize acceptable replacements. Other activities to be carried on during the year include investigating new sources of refractory materials in areas threatened with shortages, continued development of a mining machine called "a planer" to reduce the cost and increase the safety of mining western phosphate rock, and further studies of means to recover fluorine from waste gas at phosphate-processing plants.

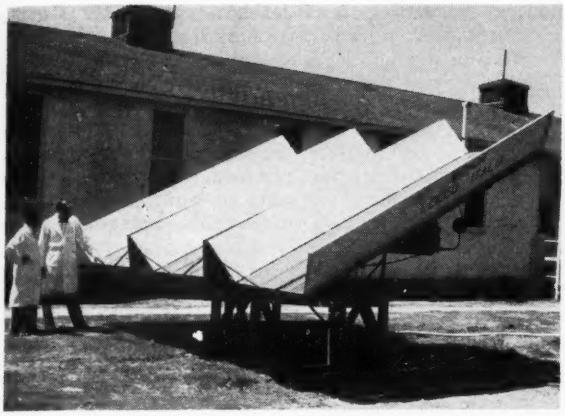


Fig. 4 This solar-powered engine has been set up for study at the laboratories of Stanford Research Institute, Menlo Park, Calif., as a part of the Institute's general program of investigation of applications of solar energy. The pump was designed and built to lift water.

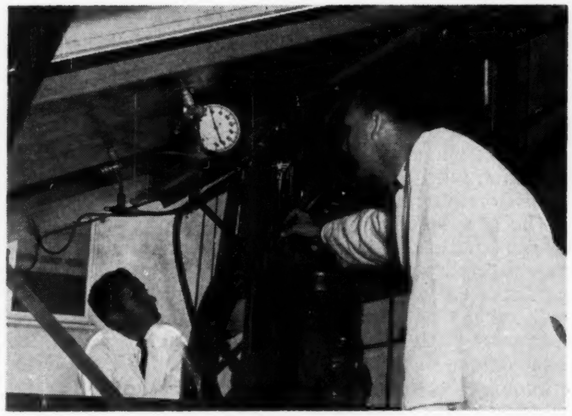


Fig. 5 Mr. Guy Benveniste (*left*) and Dr. Robert Eustis (*right*) of Stanford Research Institute, stand on either side of the engine and flywheel of the solar-powered pump built by Societa Motiori Recuperi of Lecco, Italy. In actual service a water pump would be connected to the flywheel.

Solar-Operated Pump

Pumps driven by sunshine energy have been developed and are being marketed by Societa Motori Recuperi of Lecco, Italy. These consist of flat-plate collectors through which sulphur dioxide is circulated to absorb heat and drive a simple single-cylinder engine. Each section of the collector has a set of metal reflectors painted white that augment the energy collected by the flat plates themselves. These reflectors also act as covers when needed. The sulphur dioxide leaves the collector as a vapor at a temperature of about 150 F during times of bright sunshine. After driving the engine the sulphur dioxide is recondensed to a liquid by the cool water being pumped. With a total collector surface of about 127 sq ft the engine delivers about 1 hp to the pump. The output depends both on the amount of sunshine and the temperature of the condensing water.

Stanford Research Institute at Stanford, Calif., is studying this solar-operated device and others as a part of a general program of investigation of ways to capture and utilize solar energy. The Institute, in collaboration with the Association for Applied Solar Energy and the University of Arizona, is sponsoring the World Symposium on Applied Solar Energy held in Tucson and Phoenix, Oct. 31 to Nov. 5, 1955.

Fig. 6 Bell Telephone Laboratories' engineers make final tests on a solar battery which was developed to provide more and better rural telephone service

Sun-Powered Telephone Line

For the first time, power from the sun is being furnished directly to a telephone line. Bell engineers recently switched solar power into a new type of a rural telephone system using the Bell Solar Battery, an invention of Bell Telephone Laboratories announced last year. Use of solar power is a part of experiments being conducted near Americus, Ga., 135 miles south of Atlanta, to develop more and better rural telephone service.

The Bell Solar Battery is the first successful device to convert the sun's energy directly and efficiently into substantial amounts of electricity. It is at least 15 times more efficient than the best previous solar-energy converters.

Excess current from the solar unit not needed for im-

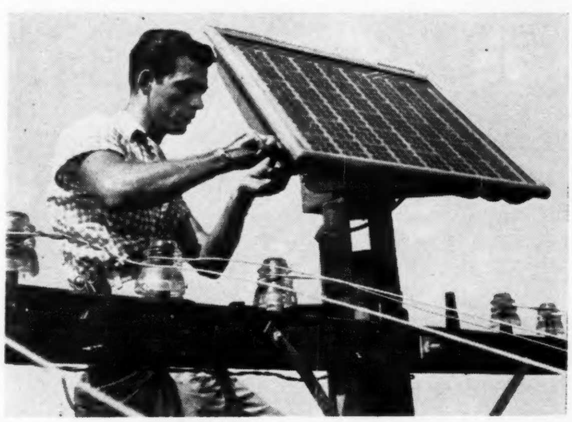


Fig. 7 For the first time, the sun—ultimate source of all the power which man has at his disposal—is furnishing power directly to a telephone line

mediate telephone use feeds into a storage battery which provides power at night and over periods of bad weather.

The solar battery has no moving parts or corrosive chemicals and therefore should last indefinitely. Even in poor light, it will continue to charge the storage battery but at lower power.

The telephone system, under trial at Americus in co-operation with Southern Bell Telephone Company, uses transistors instead of traditional vacuum tubes.

The new system uses the "carrier" principle which allows several conversations to be sent simultaneously over a single pair of wires. Since each conversation is sent at a different frequency, they do not interfere with each other. Multifrequency transmission has been used for years—with vacuum tubes—on longer-distance calls. The system on trial at Americus, however, operates economically over shorter distances such as those on rural telephone lines.

Automatic Machine-Tool Control

An automatic control which uses punched business machine cards to control machine tools has been announced by the General Electric Company's Specialty Control Department.

Called "Numerical Positioning Control," the system is adaptable for use on a wide variety of machine tools including riveting machines, placement machines, milling, boring, and drilling machines, punch presses, lathes, and shears.

The new control, it is claimed, can double or triple the productivity of many machines on which it is installed, depending on the application involved.

The control reads positioning directions from punched holes in standard business-machine cards. The directions are converted into positioning signals which direct the machine to the correct machining location. This is done through a system of command and pickup selsyns.

As the first card is read, the machine positions itself accordingly, and the machining operation takes place. While this is taking place, the next card is read and the machine moves to its next position.

At the same time the machine is being positioned by the control, machine directions are also being read from the punched cards. These directions are conveyed to the machine to initiate action in co-ordination with the positioning movements.

Normally, the machining operation would take place immediately after the machine reaches the correct position—while the next card is being read. In some applications, however, such as a lathe, machining occurs during the positioning motion. If desired, therefore, the machine action may also take place before the positioning occurs.

Standard card-processing equipment is used for punching, sorting, and stocking. Positioning information is punched into the cards in decimal form and is not coded. This permits the operator to read directions right from the card. Each card, as it is placed into the standard card reader, contains complete information for at least one machining operation.

The cards also have adequate space for a considerable number of miscellaneous directions, such as operator's instructions, in addition to a variety of machine functions.

Machine directions that would normally be programmed include tool selection and indexing, sequencing of operation, and initiating of automatic material-handling cycles.

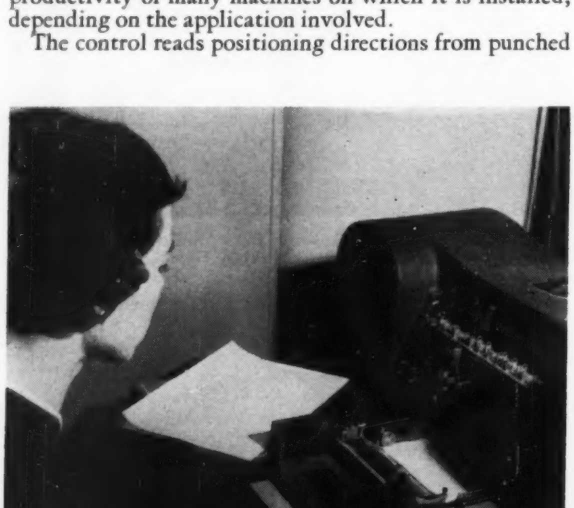


Fig. 8 Girl operates standard business machine to punch holes in the cards which later are placed into director of Positioning Control

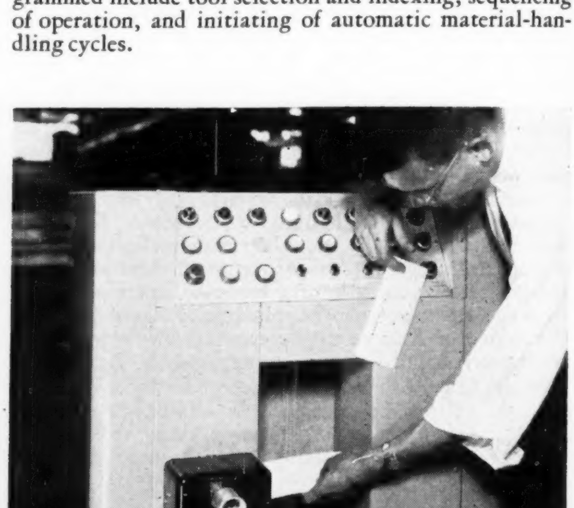


Fig. 9 Operator loads director of Numerical Positioning Control. A separate business-machine card is used for each punched hole

Once the cards are correctly punched and placed into the machine, the operator has only to push the start button and the machine automatically runs through the sequence of operations required. It directs the machine motions and initiates all machining operations until the workpiece is completed. A signal may be provided to inform the operator if manual operations are to be performed.

Consisting of a director, control panel, position selsyn pickup units, and d-c motor drives, the new control can be built to approach the desired positions from the same direction—regardless of direction of travel. This feature materially reduces positioning error caused by backlash. All positions are measured from a zero reference point, rather than from a previous position, to help prevent any possibility of cumulative position error.

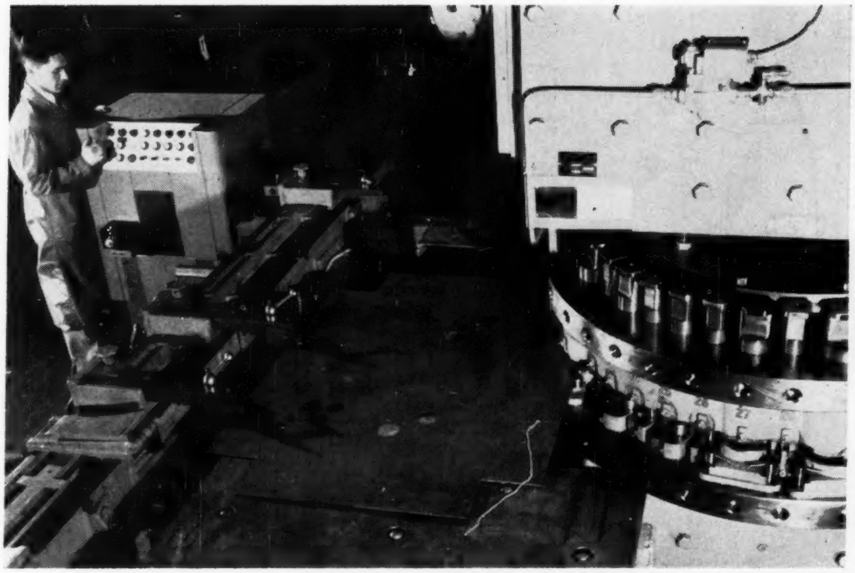


Fig. 10 Operator presses button on director of Numerical Positioning Control to set punch press into operation

Completely automatic, the control reduces material spoilage, since human error is eliminated and dimensions are consistently held within required tolerances. All positioning normally occurs simultaneously, thus decreasing positioning time. When required, positioning can occur in a preselected sequence.

The control is designed to give the user increased machine productivity, higher machine speed, and greater accuracy.

It was explained that such time-consuming jobs as positioning templates and tools, laying out hole locations, and hand checking are completely eliminated with NPC.

It was also pointed out that the control is capable of easy application and that little machine modification is necessary to adapt it for use. Its main application, however, will be by machine-tool manufacturers who will apply it directly on to their machines, rather than to have it installed on already existing equipment.

Numerically Controlled Milling Machine

After more than a year of study of automation techniques in aircraft production, Martin of Baltimore, Md., has awarded a contract to Bendix for a numerically controlled milling machine. The Bendix electronic-control system will be applied to a precision DeVlieg horizontal milling machine. Sponsored by the U. S. Air Force, this project is a production adaptation of the Numerical Control System which has been under development at M.I.T. for several years.

This, it is said, will be the first-scale test of the theory of automatically controlled machines in actual air-frame manufacturing.

Automatically controlled machining is expected to aid Air Force production programming by reducing the time span for producing new models from designer's plans to tactical weapons, and by providing a flexible, almost instantaneous means of mobilizing production in the event of an emergency.

In the numerical control system, design information is coded on a tape. The tape transmits this information through the electronic-control units directly to the milling machine, thus eliminating many of the conventional, time-consuming, and error-provoking steps such as calculating co-ordinates, laying them out on a loft, photographing the loft, and distributing it to a toolmaker who makes a template to match the loft layout, and then using the template on a profile milling machine to make the part. Simplification of these procedures will speed the tooling and production of new models.

The tape also is a compact storage medium for the design data. It is economical, comparatively nonperishable, and quickly available for re-use. It can be delivered quickly to subcontractor's plants; its impulses can be transmitted via teletype circuits to one or more dispersed machines; or it can be duplicated as needed.

The Martin milling machine will consist of a tape perforator to be used by tool engineering to program the machine operation for each part to be produced. The program tape will be fed into a computor which will convert program data into control data punched on a machine-control tape. Numerical data for cutting standard arcs and other routine movements will be preprogrammed on magnetic tape and stored in the auxiliary storage unit. When such movements occur in the program for a specific part, the director computor automatically draws these data from storage. The control tape will then be used in the machine-control unit to guide the movements of the milling-machine cutter to produce the part.

The milling machine will be a standard production model DeVlieg precision, three-axis, horizontal milling machine. The horizontal spindle machine was selected

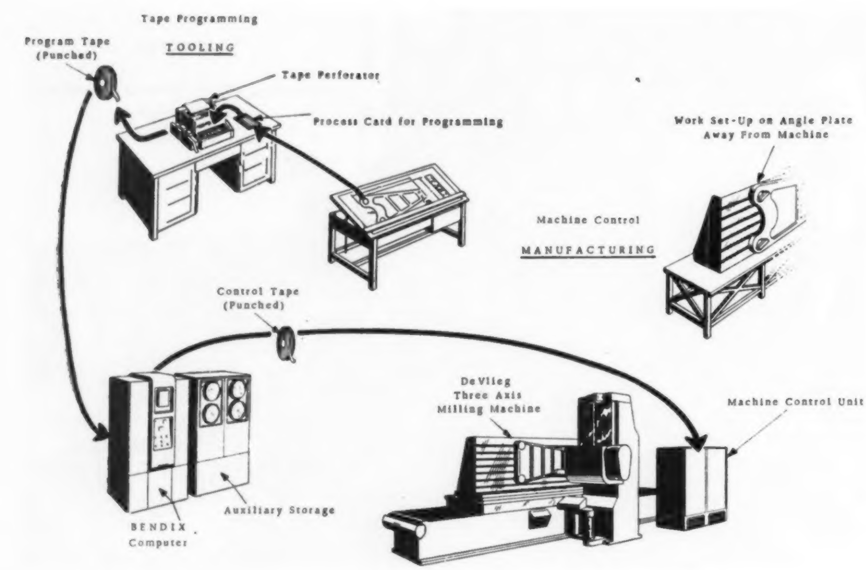


Fig. 11 Basic steps in machining with the numerically controlled milling machine to speed up production of aircraft parts

for its inherent rigidity in the machine frame, versatility in function and work range, convenient operator position, convenience of setup, and natural drainage of chips and coolant.

Heliarc Cutting

A NEW process for cutting nonferrous metals has been announced by the Linde Air Products Company, a Division of Union Carbide and Carbon Corporation. Shown at the National Metals Show in Philadelphia, Pa., on Oct. 17, 1955, the method, called Heliarc cutting, offers promise of revolutionizing nonferrous fabrication techniques. The use of a gas-shielded arc for cutting is said to make the fabrication of the nonferrous metals easy, increases the cutting speed, permits the making of sawlike-quality cuts, and greatly reduces cutting and edge-preparation costs.

Although nonferrous metals are relatively soft, they cannot be cut easily. Until now there has been no process which means to nonferrous cutting what oxygen cutting means to steel—speed, ease of application mechanically or manually, smooth-cut surfaces, high efficiency, easy adaptability to position, and contour.

Heliarc cutting employs an extremely high-temperature, high-velocity, constricted arc between a tungsten electrode and the piece to be cut. The concentrated and columnated energy of the arc stream melts and ejects a thin section of metal to form a kerf. This jetlike action removes the molten metal mechanically, and the gas atmosphere prevents oxidation of the cut face.

Investigation and experimentation have shown that best results are obtained in Heliarc cutting when employing a mixture of argon and hydrogen. For machine cutting the optimum mixture appears to be one containing 65 per cent argon and 35 per cent hydrogen. With this mixture a high arc voltage is developed. This arc voltage, however, can be readily obtained with a power supply having an open-circuit voltage of 100 volts.

In the case of manual cutting it has been determined that the optimum mixture is approximately 80 per cent argon and 20 per cent hydrogen. The lower hydrogen content is employed in manual cutting in order to provide a greater tolerance for variation in arc length than required for machine cutting.

Further, even with the lower voltage at the 80 to 20 mixture, maximum cutting speeds can be obtained without sacrificing quality of cut.

Since heliarc cutting is adaptable to mechanized or manual operations, it will find immediate use in the aluminum fabricating industry. Until now, no simple means, with the exception of saws and planers, has been available for the cutting or edge-preparing of nonferrous metals. These processes usually have been limited to straight-line cuts, and the necessary equipment is generally expensive. In the cases where irregular or curved shapes must be cut, bandsaws or hand-chipping and drilling methods have been used.

Fig. 12 Operator demonstrates use of manual Heliarc cutting

Now, Heliarc cutting brings all these features of flame cutting to the cutting of aluminum. Normal mechanical cutting speeds are 300 ipm in $^1/_4$-in. material, 125-ipm in $^1/_2$-in. metal, 75 ipm in $^3/_4$-in. plate, and 50 ipm in 1-in. material. If a lower cutting speed, for example, 20 ipm is desired, it can be obtained simply by adjusting the controls. It can be used, mechanically or manually, in any position, for cutting straight lines, bevels, circles, and shapes.

For example, in the fabrication of aluminum tank cars, made of $^5/_8$-in-thick plate, the average hand-cutting

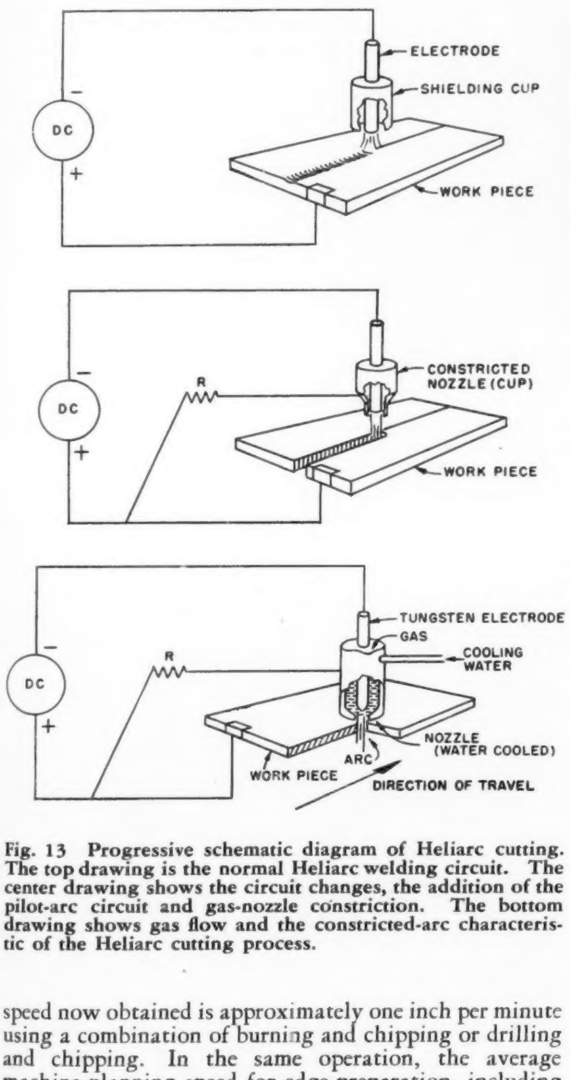


Fig. 13 Progressive schematic diagram of Heliarc cutting. The top drawing is the normal Heliarc welding circuit. The center drawing shows the circuit changes, the addition of the pilot-arc circuit and gas-nozzle constriction. The bottom drawing shows gas flow and the constricted-arc characteristic of the Heliarc cutting process.

speed now obtained is approximately one inch per minute using a combination of burning and chipping or drilling and chipping. In the same operation, the average machine-planning speed for edge-preparation, including setup and handling time is about 10 ipm. The speeds mentioned previously can be attained when Heliarc cutting is used for the mechanized operations.

The speed and quality of manual cutting vary according to operator skill with an average speed of about 60 ipm on $^1/_2$-in. aluminum plate. The kerf edges of all cuts have a sawlike quality, with square corners, and no attached dross.

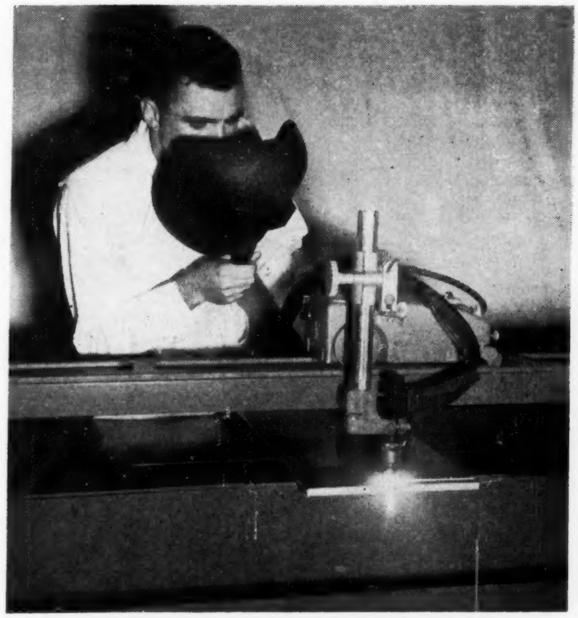


Fig. 14 Heliarc-cutting equipment for automatic operation

This process should replace many cutting and edge-preparing methods presently used in the aluminum fabrication industry. Eventually, Heliarc cutting should find wide use in the producing and fabricating industries of all nonferrous metals.

Chemical Cutting Tool

The energy potential bound up in elemental fluorine and in the halogen fluorides now has been put to use in a streamlined cutting tool which is already at work cutting and perforating steel pipe miles below the surface of the earth.

The chemical is contained in a heavy-walled cylinder equipped with a pressurizing chamber and a firing head with appropriately spaced orifices. The assembly, lowered into an oil well is positioned accurately and held against powerful thrusts by specially designed latches. Upon electrical impulse through the electronic panel and conductor cable, the chemical is ejected under enormous pressure against the inner pipe wall, which it penetrates in a fraction of a second.

By changing the placing of the openings, the tool makes a clean cut, with none of the objectionable flaring produced by previously used explosive methods. It also perforates a smooth, burrless hole.

The new tool was developed jointly by the McCullough Tool Company of Houston, Texas, and Los Angeles, Calif., and the Pennsylvania Salt Manufacturing Company of Philadelphia.

Those who are familiar with the halogen fluorides and the drilling of oil wells will recognize that the correlation of these two problems had not been simple. The properties of this chemical family are striking; they cause immediate ignition of any organic material, react explosively with silicon compounds, and will set fire to asbestos. On the other hand, oil wells are deep and

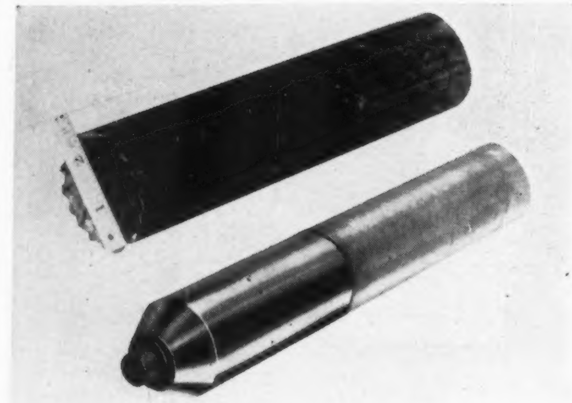


Fig. 15 *Top:* **Sample of 2-in. tubing cut by chemical cutter. Note absence of flare or distortion.** *Bottom:* **Cutter head of chemical tubing cutter.**

small. Oil pressures and temperatures are extremely high. It is under these conditions that workers at the surface have to manipulate tools in deep and narrow spaces to perform the precise perforating and cutting operation.

W. G. Sweetman of McCullough, seeking to overcome the limitations of mechanical, gun, and explosive-jet tool devices for use in the narrow confines of a well bore, conceived the method of combining the reactive properties of fluorine and its more reactive compounds with the effect produced thereon by the application of pressures. Thus he found he could greatly accelerate the rate of release of maximum amounts of energy by the chemical compounds, and concentrate it effectively at the desired points on the surfaces to be attacked.

He called on Pennsalt, because of its prominence and experience in the manufacture and handling of fluorine and its compounds, to aid in the selection of the compounds best adapted for his purpose and in the solution of the various problems necessarily associated with packaging, loading, storing, and handling of the highly reactive compounds involved.

During the past year the chemical cutter for 2 and $2^1/_2$-in. tubing has been employed successfully in many commercial operations at depths of a few hundred to many thousand feet, and McCullough is getting geared productionwise to meet the growing demand for this tool. In addition, a chemical cutter for casing has been developed and will be available for commercial use in the near future. Halogen-fluoride perforating tools have already been designed which show distinct advantages over present bullet and jet performance. Research also is being conducted on the development of a tool for drilling wells through extremely hard formations, an operation which is now slow and expensive with diamond bits.

Welding Equipment

Automatic Welders

The Lincoln Electric Company of Cleveland, Ohio, has developed a new line of equipment for hidden or submerged arc welding. Included are three new welding heads, new controls and adjustments, new accessories, and two new power sources.

The new welding heads, LAF-3, LAF-4, LAF-5, offer to users a choice of heads for either a-c or d-c field or shop welding, and constant potential or variable voltage power source. New operation controls permit a choice of instantaneous starting, either hot for intermittent welding or cold for precision starting; a choice of variable inching speeds, either slow or fast, away from or to the work; a choice of carriage operation to give standstill starts, flying starts, or manual control.

The heads are designed to permit easy adaptation to fixtures, either as a complete unit or as separate components. They can be positioned universally in any angle in three dimensions or off center for round-about welding, and can be positioned on seam while welding. Fine vertical adjustment up or down is made by a simple hand screw and can be made while welding. Either welding jaws or a welding nozzle for more precise placing of flux can be used. Flux flow start or stop is controlled either automatically or manually. All controls are comparatively simple, using only rheostats, switches, and relays so that any electrician can service the equipment or adapt it to fixture controls. Field operation is possible from engine-driven welders without additional line power being needed.

Electrodes in sizes from $^3/_{32}$ in. to $^1/_{32}$ in. are handled by one set of drive rolls, easily accessible through a hinged door. A separate set of easily changeable rolls handles $^5/_{64}$-in-diam wire. A roller-bearing wire straightener with a single adjusting screw can be swung 360 deg about a vertical axis to accommodate wire reels in any position.

In addition to heads, mounting equipment is available to give either a stationary mounting, mounting on a self-

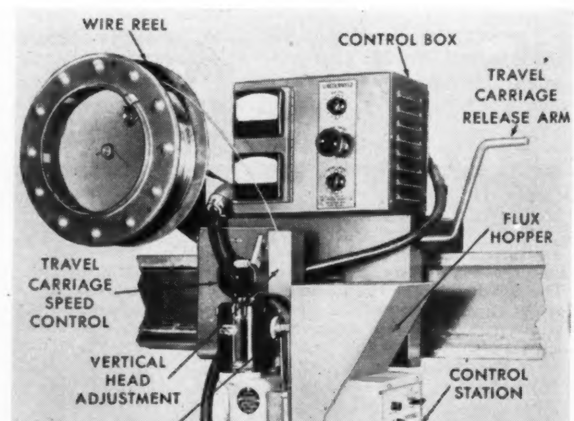


Fig. 16 Automatic welding head for hidden or submerged arc welding

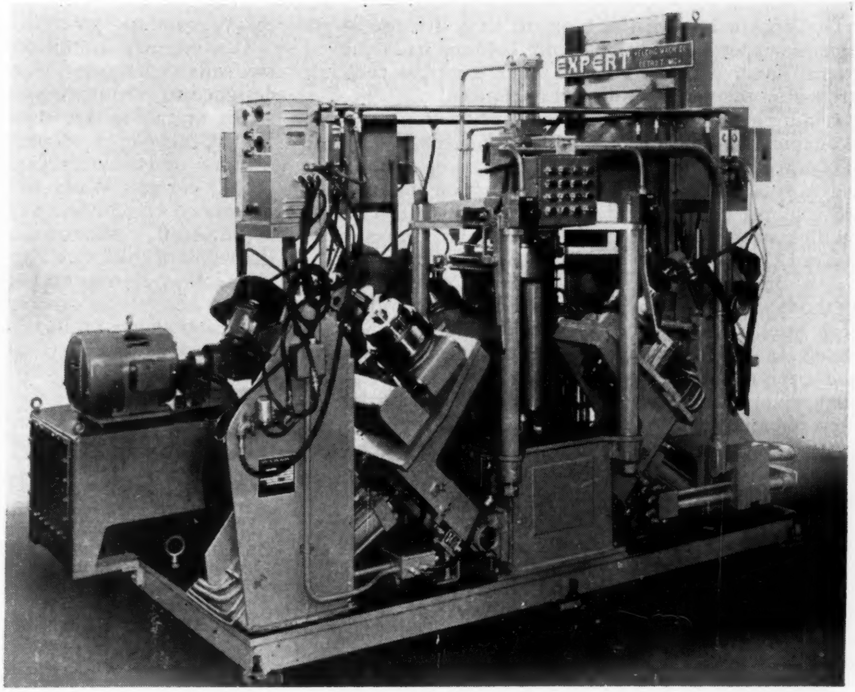


Fig. 17 Triaxial Welder assembles and welds two sheet-metal fluid coupling parts together at a rate of 300 assemblies per hr with one operator

propelled travel carriage, or on a self-propelled tractor. The heads can be adapted for Twinarc or tandem arc welding or for an oscillating attachment, the Spreadarc.

A new Lincolnweld power source has been added to the line in the Lincolnweld AC-750, which gives 750 amp continuous duty a-c power. It has a power-driven reactor control for setting current from remote switches on the welding-head control box. Taps for Scott Connections are available where setting up power supply for tandem welding. These furnish 90-deg phase relationship for welding current from 3-phase current supply.

Another new power source is the Lincolnweld DC-750, which is a motor-generator machine specifically designed for automatic welding. It is rated at 750 amp, continuous duty at 40 volts. It can also be paralleled with a second DC-750 for work requiring higher amperages.

High-Production Welding Machine

A new high-production welding machine that utilizes automation methods to combine assembly and argon shielded-arc welding operations has been designed and built by Expert Welding Machine Company of Detroit, Mich. One operator can assemble and weld two 8-in-diam sheet-metal fluid coupling parts at a rate of 300 finished assemblies per hour on one of the new machines.

Called the Triaxial Welder, the machine consists of a special vertical hydraulic assembly press and three standard argon shielded-arc welding heads. These welding heads are positioned at 90-deg locations around the assembly press. High production rates are achieved by performing the welding operation on two fixtures while parts are being assembled in a third fixture by the press. To accomplish this, three unique automation devices transfer the fixtured and assembled part to the welding head, rotate the fixture and part at a speed of 90 ipm for the welding operation, and return the fixture and part to pressing position for unloading.

Hydraulically controlled pivoted fixtures act as automation devices to provide the required transfer and rotation movements. The three fixtures are pivoted at the base of the press. Individual hydraulic cylinders control the motion of the fixtures in and out of the press. Hydraulic motors rotate the assembled part and fixture as a unit during the welding operation.

A separate hydraulic power pack supplies power for all control and operating functions. Separate electrical and welding control panels are provided. Individual operating buttons are provided for each fixture to facilitate setup operations. Panel lights indicate the operating condition of each automation fixture. All fixtures are separately and independently operated, permitting the machine to continue to produce parts while one or two of the fixtures are locked out for maintenance.

The Triaxial Welder occupies a floor space about 5 ft × 10 ft. It is 7 ft high.

Oil-Shale Mining Research

Special research intended to develop a safer and more economical method of mining oil shale will be undertaken in Colorado by the Bureau of Mines under a $1,000,000 supplemental appropriation from the Congress, it was announced by the Department of the Interior.

The planned mining program, to be carried on at the Experimental Oil Shale Mine at Rifle, will explore new and modified techniques in large-scale underground mining and will be based in part on recommendations of a committee of outstanding mining engineers who have made a study of the Government property.

The Bureau has been mining oil shale for use in its retorting experiments at Rifle since 1946 and had removed several hundred thousand tons when a serious roof fall last winter temporarily stopped operations.

A mining method that had been developed, using large mechanical equipment and a carefully planned schedule of operations, had indicated oil shale can be mined commercially at a very low cost. Production had reached 148 tons per underground manshift during a test run at the Bureau's experimental mine. The shale mined there assayed 30 gal of oil per ton.

The Bureau reported it is studying several mining methods and hopes to test at least two that look most promising in the renewed experimental mining. Some of the shale will be stock-piled for the future, and small quantities may be sent to the Bureau's Petroleum and Oil-Shale Experiment Station at Laramie, Wyo., for laboratory research.

Hot-Cell Laboratory

The first of three major units in Battelle Memorial Institute's new atomic-energy research center, in Columbus, Ohio, has been completed recently. It is known as a "hot-cell" laboratory and it is America's first of its capacity to be built without Federal funds. When all units are completed, the center will provide $3.5 million worth of facilities available to both industry and government for such research.

A power-reactor development (critical-assembly) laboratory—the second unit at the new center—is scheduled for completion later this year at Battelle's 400-acre site just west of Columbus, Ohio. It is designed specifically for use by industry in the development of commercial power-generating plants.

The third unit will be a 1000-kw swimming-pool-type research reactor designed to operate on U-235 fuel. The building to house this unit is well under way, and the American Machine and Foundry Company of New York has designed and is constructing the reactor assemblies. The reactor is scheduled to be installed before the end of this year and to "go critical" during the spring of 1956.

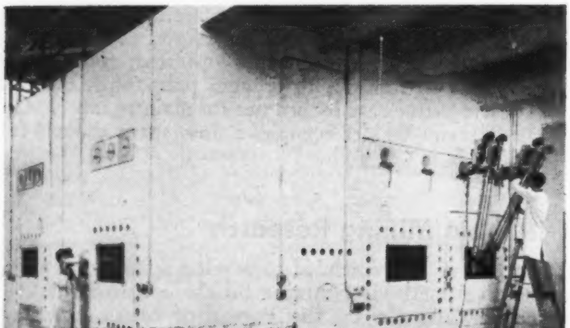


Fig. 18 Lead plugs are inserted in access holes of one hot cell, and adjustments made on one pair of master-slave manipulator arms, as one of Battelle's two hot cells is readied for operation. Four of the six shielding glass windows are shown.

The recently completed hot-cell laboratory houses two cells with inside dimensions of 18 × 8 × 12 ft. One is designed to permit the safe handling of up to 10-million curies of radioactive material that emits gamma rays having an energy of one-million electron volts. The other is designed for gamma-radioactivity levels up to 10,000 curies. Walls of the cells are made of high-density concrete, 2 and 3 ft thick, clad on both sides with 1/2-in. steel. Windows are of high-density glass and doors are of solid steel, up to 18 in. thick, and weighing as much as 20 tons each.

The hot-cell laboratory will be used for studies of radiation effects on materials, nuclear-fuel reprocessing, radioactive waste disposal, and the processing of radioisotopes.

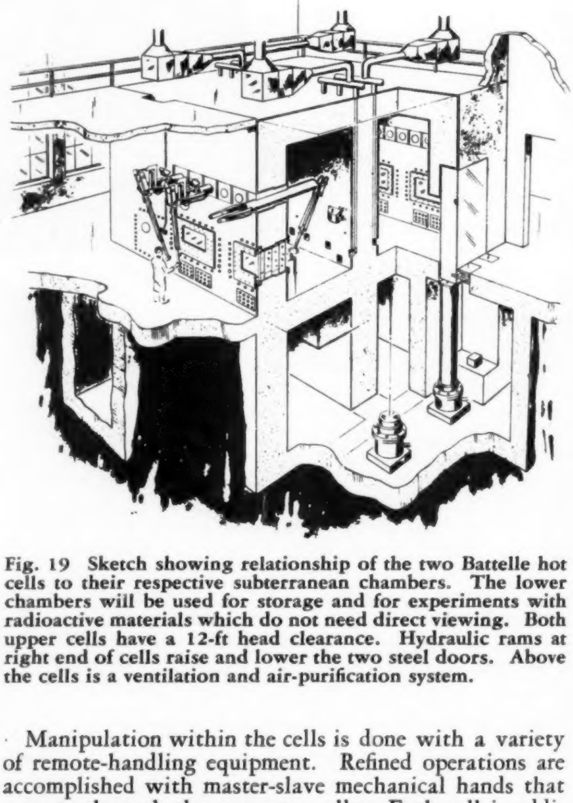


Fig. 19 Sketch showing relationship of the two Battelle hot cells to their respective subterranean chambers. The lower chambers will be used for storage and for experiments with radioactive materials which do not need direct viewing. Both upper cells have a 12-ft head clearance. Hydraulic rams at right end of cells raise and lower the two steel doors. Above the cells is a ventilation and air-purification system.

Manipulation within the cells is done with a variety of remote-handling equipment. Refined operations are accomplished with master-slave mechanical hands that operate through the concrete walls. Each cell is additionally provided with a one-ton crane for the handling of heavy equipment and materials. Tools and instruments within the cells have been modified so that they can be operated remotely by mechanical or electrical linkages running through the shielded walls.

Unique features of this hot-cell laboratory are subterranean chambers located below the two cells. Here radioactive solutions can be stored, and operations can be conducted that need no direct viewing or manipulations. Hatches in the floors of cells can be opened to make these underground spaces available for the operation of tall equipment, such as chemical columns, that cannot be accommodated in the 12-ft clearance of the cells proper.

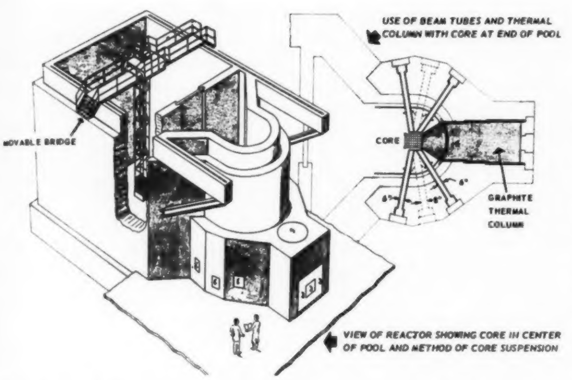


Fig. 20 Battelle's swimming-pool-type reactor, designed for maximum flexibility, will serve as a neutron and gamma-ray source for varied experiments. The drawings show several locations where materials to be irradiated can be brought close to the reactor core which is suspended from a movable bridge in 28 ft of water. The main pool is 20 ft wide and 40 ft long. The foundation of this swimming pool has already been cast and the reactor is slated to begin operation in the spring of 1956.

Most of the equipment in the cells is mounted on portable tables to provide flexibility in interior arrangement. An exception is the optical equipment that cannot be conveniently moved. One end of the lower-radiation-level cell contains a permanent installation of a remotely operated metallograph, a remotely operated milling machine, a lathe, analytical balances and chemical apparatus, and linear gages. Periscopes are provided for magnified viewing and photographing radioactive specimens.

Associated with the cells are a decontamination room for cleaning equipment, a large underground-storage area for solid radioactive materials, and a 14-ft-deep tank for the storage and handling of radioactive materials under water. The building also houses general laboratory areas, a machine shop, locker rooms, and offices.

Feeding Atomic Furnaces

Most experts expect that within 10 years atoms will power a great many more things than submarines alone. Also, it seems likely that the nuclear fuel will be "burned" in some form of breeder reactor—which creates more fissionable material than it consumes—rather than a nonbreeder. Nonbreeder reactors would soon use up nature's limited supply of U-233. The real question: Will future "furnaces" be homogeneous or heterogeneous breeder reactors? (Homogeneous ones have fuel and moderator together; heterogeneous breeder reactors have fuel and moderator separate.)

According to a recent issue of "Columbia Research News," Prof. T. Ivan Taylor and Dr. William Spindel of Columbia University's Chemistry Department, have perfected an isotope-separation method for nitrogen 15 that may weight the scales in favor of a homogeneous breeder reactor.

In the thorium-type breeder reactor, a core of U-233 is surrounded by a liquid thorium blanket. As U-233 atoms fission in the core, they shoot their neutrons into thorium 232 contained in the blanket—converting them to fissionable U-233. The new U-233 is then continuously removed by processing the blanket. Most of it goes back in the reactor to keep the "fire" going, some atoms are lost, and any surplus can be put into the core of a new reactor to get it started. Energy from the atomic furnace comes, of course, from the enormous heat generated during fission.

Thus far the liquid thorium blanket has been a problem. Thorium nitrate, $Th(NO_3)_4$, is one of the few soluble compounds that can be used. But when made with ordinary nitrogen 14, it absorbs too many neutrons and thereby lowers the yield of new fuel. Made with nitrogen 15, however, the thorium nitrate absorbs few neutrons, because of that isotope's low-absorption cross section. Unfortunately, nitrogen 15 is present in nature to the extent of 3.8 parts in 1000 of ordinary nitrogen; it now sells for about $300 per gram!

Professor Taylor estimates that his isotopic-exchange reaction for making nitrogen 15 will cut its cost in half. A plant for making it would cost about one third as much as those in use.

In brief, the method uses a series of chemical-exchange columns in which nitric-oxide gas turns over its nitrogen 15 to nitric acid. This is repeated, with a 5 per cent enrichment of the isotope for each stage, until the nitric acid is rich enough to be drawn off. Professor Taylor believes that about 250 stages with some 200 ft of columns in cascade would produce 95 per cent nitrogen 15.

Nuclear Briefs

Small-Scale Nuclear-Power Plants. Lewis L. Strauss, Chairman of the Atomic Energy Commission, announced that the Commission is inviting proposals for the development, design, construction, and operation in the United States, its territories and possessions, and the Canal Zone, of power reactors in a wide range of capacities, to demonstrate the practical value of such units for commercial use.

The invitation calls for proposals especially directed to nuclear-power plants with the following capacities: 5000 to 10,000, 10,000 to 20,000, and 20,000 to 40,000 kw of electricity. The closing date for receipt of proposals is Feb. 1, 1956.

Turbine-Generator for Atomic Plant. Duquesne Light Company of Pittsburgh, Pa., has awarded the Westinghouse Electric Corporation a $2,500,000 contract to build the turbine-generator for the nation's first commercial atomic-powered electric-generating station at Shippingport, Pa.

The Shippingport project is scheduled for completion in 1957. Westinghouse, under AEC contract and supervision, is building the nuclear reactor for the plant. Duquesne Light will build the electric-generating portion of the new plant and will operate the entire station.

The turbine-generator contract announcement calls for a unit with a capability of 100,000 kw.

Electric Power for Portsmouth Project. Ohio Valley Electric Corporation announced it had passed the halfway point in the bringing into service of facilities to supply the full electric-power requirements of the Atomic Energy Commission's Portsmouth (Ohio) Project.

According to OVEC officials, the job is well ahead of schedule, with good prospects for maintaining, or even bettering, the record in the remaining months of the schedule.

The halfway mark was passed when the sixth of 11

giant steam-electric generating units being built by OVEC was completed and placed in operation early in September. Actually, from the standpoint of over-all work completed and equipment erected, the job is about 85 per cent completed. The first two OVEC units went into service on February 15 of this year; the completion of the sixth brought OVEC capability up to 1,290,000 kw—the largest block of electric power ever placed in operation in such a brief period in the history of the electric-utility industry.

Nuclear Studies. The University of Minnesota will participate in a program being carried out in the field of atomic energy by three Minnesota corporations.

The program, launched last spring by Northern States Power, Minneapolis-Honeywell, and General Mills, is concerned with the study and evaluation of peaceful uses of atomic energy that would be of most benefit to the state and its industries.

The University would become a full member of the operating committee of the Minnesota Nuclear Study Group, established jointly by the three companies to carry out the program.

The University's participation in the program represents an extension of research work that various University departments have been carrying on for some time in the use of radioisotopes.

USS "Saratoga" Propulsion Equipment

The U. S. Navy's newest aircraft carrier, the USS *Saratoga*, was christened at the New York Naval Shipyard, Brooklyn, N. Y., on Oct. 8, 1955.

The *Saratoga's* propulsion equipment, first of its kind, will develop over 200,000 hp—more than that of any ship built including her sister ship the USS *Forrestal*, and the luxury passenger liner, SS *United States*. It will drive the 60,000-ton carrier at a top speed "in excess of 30 knots," or more than 34 mph.

The turbines for this equipment will operate at the highest steam temperatures and pressures of any vessel built for, and accepted by, the U. S. Navy to date.

Engineering requirements called for the development of many new designs and production techniques. It was particularly true with regard to the propulsion equipment which required a completely new design for turbines and gears.

This new marine power plant was designed and developed by Navy and General Electric Company engineers to meet the unique specifications. The main propulsion equipment, which consists of four cross-compound turbines and four double-reduction gears, was built at G-E's Medium Steam Turbine Generator and Gear plant in Lynn, Mass.

With the use of the highest pressure and highest temperature steam in her propulsion turbines, the *Saratoga* is designed to operate with the greatest efficiency ever attained in a large naval vessel. Lighter and less bulky than World War II types, these turbines also will burn less fuel even though developing greater shaft horsepower. In addition, these new-type turbines will enable the *Saratoga* to steam efficiently at full power as well as lower cruising speeds.

The alloy-steel propulsion gears, which connect the turbines to the *Saratoga's* four propeller shafts and reduce the fast speed of the highly efficient turbines to a slower and more efficient shaft speed, are also of a new lightweight design. Notwithstanding their size and rating, these gears are 50 per cent lighter over all than if they had been built according to World War II design. This means the *Saratoga* will have an increased capacity for thousands of gallons of aviation fuel or increased cruising radius.

Load tests for the gears included operation at full speed. In other tests the gears were successfully subjected to an equivalent of several years of normal operation.

An over-all feature of the marine power plant is its compactness. Although propelling a vessel 1039 ft long and 252 ft wide, this equipment will occupy less than 8 per cent of the ship's total cubic space.

Steam for the propulsion turbines, ship's service and auxiliary turbine-generators, plane catapults, and other ship's equipment using steam will be supplied by eight giant oil-fired boilers built by Babcock & Wilcox.

Control of the boilers, turbines, and other elements of the *Saratoga's* propulsion plant is almost entirely automatic. Operations will be directed through push buttons and levers from air-conditioned control rooms in the engineering spaces. These controls will be similar to those used in a modern electric-power plant.

Construction of the *Saratoga* was begun at the New York Naval Shipyard in December, 1952. Following her christening, she is scheduled to be completed and commissioned early next year. When completed, in addition to the most powerful propulsion equipment, she will contain several other advances in aircraft-carrier design aimed at keeping pace with the rapid evolution of naval aviation, including angled flight deck and steam catapults.

Curing Silicone Rubber

Silicone rubber is now being cured successfully using carbon-black fillers instead of the conventional silica-type fillers, according to an announcement by the Silicones Department of the Linde Air Products Company, a Division of Union Carbide and Carbon Corporation. This advancement has been made possible through the use of Linde W-96 silicone, a new type of gum stock featuring controlled reactivity.

Up to now it is believed to have been impossible to secure satisfactory reinforcement with carbon-black fillers in silicone rubber under production conditions. However, Linde reports that many of the blacks tested have given reinforcement equal to that obtained with silica fillers. Comparison of typical postcured properties of a carbon-black-filled rubber point up this similarity in reinforcement:

Property	Carbon-black rubber	Silica rubber
Hardness (Shore A)	54	54
Tensile strength, psi	750	720
Elongation, per cent	270	250
Compression set[a]	47	13
Brittle point, deg F	—90	—93

[a] Method B, per cent of original deflection, after 22 hr at 350 F.

On the other hand, Linde points out, carbon-black-filled silicone rubber is essentially an altogether new product, and should perhaps be judged by different standards from conventional silicone rubbers.

The special properties of silicone rubber are well

known to the rubber industry, and have been used to advantage for several years, but Linde expects many new applications for silicone rubber will be opened up by this new development. As an example, Connecticut Hard Rubber Company has molded conductive silicone rubber that will be usable at temperatures above, and below, the limits of organic rubbers. It is believed that a material of this type will prove useful for applications such as airplane deicers, where the properties of an organic or silicone rubber alone have not been able to meet the requirements. Linde expects rapid development along these lines, since many of the techniques used in compounding organic rubbers should be applicable to the new silicone rubber.

Nickel Films

"Mining for Nickel"

A NEW film, "Mining for Nickel," on the mining operations of The International Nickel Company, was released recently by the company.

Two years in the making, the 45-min sound color film outlines briefly the history of nickel mining in the Sudbury area of Canada and covers in detail the original development of a mine and the six methods of extracting ore employed by Inco.

Explosion shots, one of which moves 500,000 tons of ore, and unusual shaft-sinking operations add dramatic action to the picture. For these shots, including underground blasts, the cameras had to be protected. In some cases expendable cameras were used. Hot plates often had to be used to keep the cameras from freezing.

Animation is used to demonstrate the fundamental principles of mining engineering and illustrate methods of economically extracting ore from the earth.

Prints of "Mining for Nickel" are now available for technical societies and educational, industrial, and civic groups through the Douglas D. Rothacker, Jr., organization, 729 Seventh Avenue; or The International Nickel Company, Inc., 67 Wall Street, New York, N. Y.

"Ductile Cast Iron"

Also available from Inco is the first motion picture on the properties and applications of ductile cast iron.

Called "Ductile Cast Iron," the 15-min sound color film graphically illustrates the fact that the new engineering material which can be cast like gray iron has properties similar to steel. Ductility of the iron is illustrated by bending, twisting, impact, and tensile tests.

This film incorporates five years of production experience and use of this material. Among the illustrated applications are gears, pinions, plowshares, pistons, and pneumatic couplings.

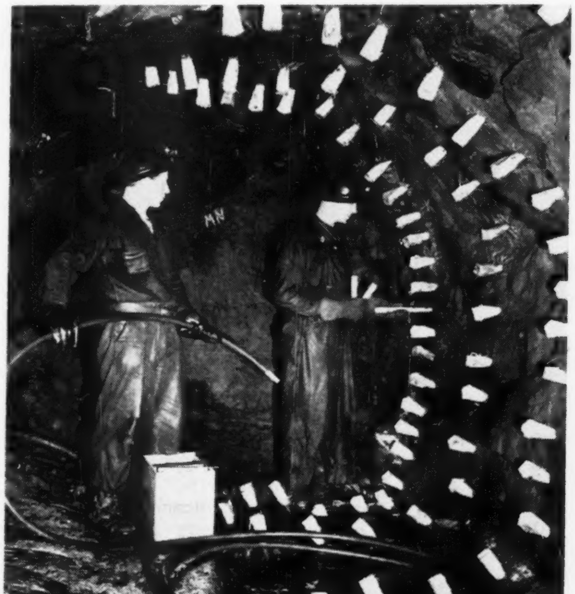


Fig. 21 The miner at the *right* in this scene from "Mining for Nickel" is shown loading one of the 2000 holes drilled for the recent record blast at International Nickel's Frood-Stobie Mine in which two giant blocks containing 400,000 tons of ore were broken. His companion holds a hollow plastic loading stick which, fitted with a wooden plug, is used to tamp the sticks of powder firmly in the holes. The plastic stick is also used for cleaning out each hole before loading, by connecting it to the mine's compressed-air line.

Fig. 22 This massive crusher is one of five recently installed by Inco in its Creighton and Frood-Stobie Mines as part of the company's underground-mining expansion program. The 185-ton machine, *left,* crushes about 500 tons of ore an hour, reducing it to 8-in. chunks. Ore dumped from haulage cars at the underground tipple rumbles down a chute leading to the crusher, which has a swing jaw weighing $18^3/_4$ tons. The speed of the ore feed to the crusher is regulated by seven huge chains with 110-lb links and a total weight of $14^1/_2$ tons.

Alfred Iddles, Fellow ASME, *left*, president of The Babcock & Wilcox Company, describes to Dr. Willard F. Libby of the U. S. Atomic Energy Commission a model of a core of a reactor similar to one B&W has contracted to build for Edison's proposed atomic-power plant at Indian Point, N. Y. Cutaway in center of photo shows fuel-element plates where actual atomic fission will take place. Mr. Iddles and Dr. Libby collaborated in ceremonies opening the show.

Detroit Edison President Walker L. Cisler, Fellow ASME, head of the Atomic Power Development Associates, Inc., comments on technical details of an atomic-electric power plant like the one represented by the model in the foreground. Mr. Cisler holds a slug of uranium which can be made to yield as much heat energy as 4500 tons of coal. At *right* is Robert W. Hartwell, Mem. ASME, director of Detroit Edison's Nuclear Power Development Department.

First U. S. Trade Fair of . . .

. . . The Atomic Industry

The First U. S. Trade Fair of the Atomic Industry was held under the auspices of the Atomic Industrial Forum, at the Sheraton-Park Hotel, September 27–30, 1955, in Washington, D. C. The fair accompanied the third annual meeting of the Forum. Several thousand representatives from government and industry attended this highly successful trade fair which included more than 70 American and foreign industrial exhibits.

As for the Forum meeting, more than 1000 persons registered for the technical discussions. The theme of this meeting, "Commercial and International Developments in Atomic Energy," was carried through in 14 separate panel discussions on such topics as power reactors, marketing atomic products and services, reactor safety, gearing up to atomic activities, AEC responsibilities in commercial developments, and fuels and source materials.

Alfred Iddles, Fellow ASME, Vice-President (Acting President), Atomic Industrial Forum, and president, The Babcock & Wilcox Company, on opening the first Trade Fair of the Atomic Industry, declared that this was an historic occasion.

"The Trade Fair will indicate the diversity and scope of this new industry," he said. It will demonstrate that this is an industry of considerable magnitude, and that it will affect our lives in many ways. It will indicate that a most impressive start has been made, and it no doubt will suggest that there is a long way to go in the years ahead.

"Here you will find a variety of nuclear-reactor models, of the components which go into those reactors, of concepts of fuel processing, and of reprocessing irradiated or partially spent fuel. You will find equipment for handling radioactive substances, for measuring their intensity, for using these substances in many interesting and useful ways. You will see metals which this industry will require, metals which have unique properties and characteristics. You will see how workers are protected from radiation, how fluids and gases and solids are moved by means of remote control.

"You will see here also exhibits from Canada and the United Kingdom. You will see the U. S. Quartermaster Corps exhibit showing some of its work with atomic radiation for food preservation.

"Many of the exhibits we are about to see," Mr. Iddles continued, "could not have been built a year ago, because what they represent was not available then or could not have been shown publicly because of security. This exhibit is evidence that the world of the atom has changed and progressed a great deal in the past year. However, it is bound to change a great deal in the years ahead."

The Combustion Engineering, Inc., exhibits featured pictorially and by models the company's current work in the nuclear-power field. Photographic enlargements reveal interesting details of the huge reactor vessel (230 tons) being built for the Shippingport Station. An actual piece of the $8^{5}/_{8}$-in-thick stainless-clad-steel plate being used in the reactor shell, as well as a full-scale model of one of the $6^{1}/_{2}$-ft-long 600-lb studs used to secure the reactor head against an upward force of 25 million lb, were shown. Other portions of the exhibit related to nuclear components built for the USS *Seawolf* and its prototype, and to the recent contract the company has received from AEC for the design, development, and manufacture of a complete submarine reactor system.

Model of the aqueous homogeneous power breeder displayed by Foster Wheeler Corporation. This model permitted the audience to operate the unit through a control board located at the front of the model. Such a plant, with an electrical capability of 150,000 kw, has been offered to industry by the company at an estimated cost to the owner of $21,000,000.

A three-dimensional presentation of Con Edison's proposed Indian Point nuclear electric generating station formed part of Con Edison's display. The exhibit also included a scale model of the reactor itself, together with an animated flow chart explaining the physics of the $55,000,000 station which will produce 236,000 kw.

European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] *Mem. ASME, European Correspondent*

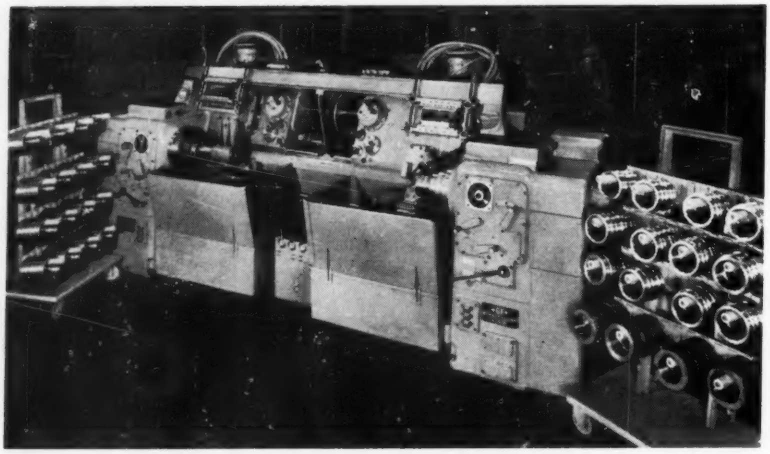


Fig. 1 Double automatic copying lathe for machining bearing races

Double Automatic Copying Lathe

The Swiss firm of George Fischer, Ltd., of Schaffhausen, who have specialized for many years in the construction of copying lathes, have developed a new type for the automatic machining of races for ball and roller bearings, or similar ring-shaped components.

A general view of the machine is given in Fig. 1 and Figs. 2 and 3 show some of its features in more detail. It is suitable for either external or internal copying and, as the two headstocks work independently, one spindle can be used for turning inner races while the other is working on the corresponding outer races, so completing the pair simultaneously. A more usual method of operating, however, is to remove the finished work from one side and load with a new blank while the other side is machining another workpiece. Thus one man can attend to both of the copying units.

The copying slide is mounted on the feed carriage and can be set at 60 deg, 90 deg, or 125 deg to the axis of rotation, the change from one position to another being quickly and easily made. At the 60-deg and 125-deg settings, right-angle shoulders can be turned, and at the 90-deg position, spherical profiles. External or internal copying is possible in all three positions. By using a double toolholder, or a boring bar fitted with two cutting tools, opposite shoulders can be turned in successive cuts by feeding first in one direction and then in the other. With the automatic swiveling template holder, cuts can be taken in succession from two different templates without any intermediate adjustment of the machine. Micrometers are provided at both ends of each template holder to enable it to be set horizontally and vertically. These can be seen in Fig. 3. The small white diamond between the holders is the end of the tracer head.

The automatic sequence control, which is of a new design, is operated hydraulically, the operations being regulated by the arrangement of grooves and bored holes in a cylindrical valve. Each different sequence requires its own special valve, but a valve can be removed and another substituted in a few seconds. Each headstock has its own separate drive, from a 30-hp motor, and the 12 spindle speeds range from 63 to 355 rpm. The height of the center above the bed is 12 in.; the maximum and minimum external turning diameters are 16.53 in. and

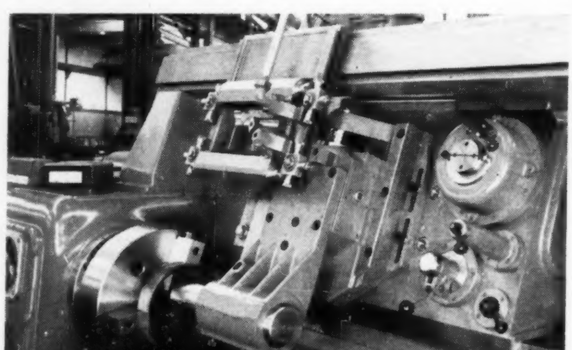


Fig. 2 Internal copy-machining of ring on double automatic copying lathe

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

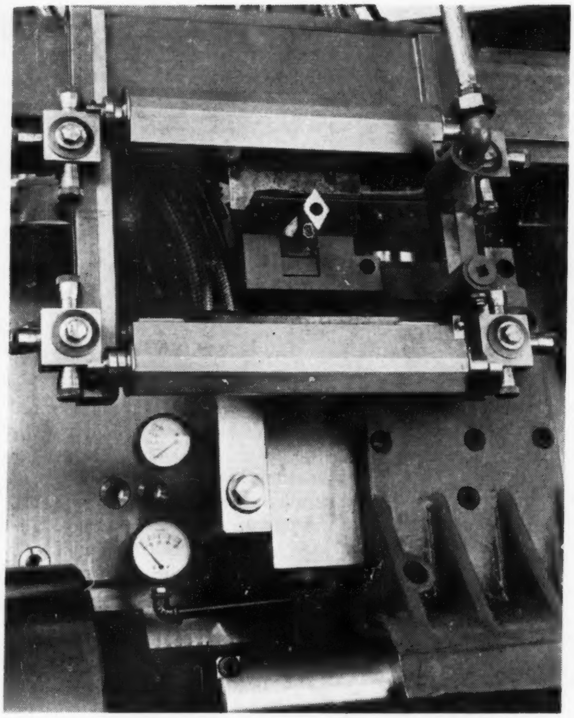


Fig. 3 Close-up of template holders, showing micrometers for vertical and horizontal adjustment. Template and tracer can be seen under the upper holder.

4.72 in., respectively; and the maximum turning length is 6.69 in. The copying slide has a travel of 3.54 in. The nose of the main spindle is to American Standard A 1. The hydraulic feed is steplessly variable between 0.005 in. and 0.035 in., and there is a rapid traverse of about 60 ipm.

British Railways Track Test Plant

An essential part of the £1200 million program of modernization of the British railway system, announced some months ago by the British Transport Commission, is the progressive introduction of electric and diesel traction and the provision of many more high-speed trains. As an adjunct to this plan, the Commission have recently authorized the construction of a length of test track for the investigation of the performance of locomotives, passenger rolling stock, and freight vehicles over tracks in various conditions of wear and over a wide range of speeds. Hitherto such studies have had to be made on tracks which had also to accommodate normal traffic and therefore are difficult to organize without interference with the regular train services.

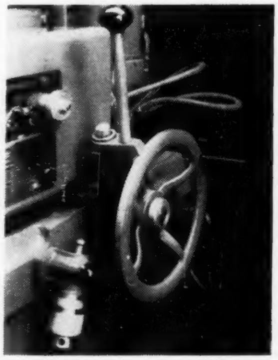
It has now been decided to construct nearly $3^3/_4$ miles of special track, both straight and curved, to be used for test purposes only. The site selected is in the county of Staffordshire, not far from Derby, which is an important center for the construction and repair of locomotives and rolling stock, and which is also the main research establishment for British Railways. In this district there is a stretch of practically straight track, forming part of the main line between Derby and Birmingham and about $3^3/_4$ miles long; the new test track will be laid parallel with it, on the east side. It will be so designed that any desired condition of wear can be artificially created and controlled, and new types of equipment or components incorporated, without having to relay lines that are in ordinary use. It will be designed for speeds up to 60 mph only, but arrangements are to be made for running at higher speeds on suitable lengths of various main lines.

To deal with the additional testing work involved, the present engineering laboratories at Derby will be doubled in size and provided with new equipment for testing vehicle frames, bridge members, and track assemblies and components. It is expected that the whole installation, the first of its kind in Europe, will take about two years to complete.

Centerless Plunge Grinding

When a centerless grinder is used for plunge grinding, it is usual for the workpiece to be slightly withdrawn from the wheel at the beginning of the operation and then advanced toward it by moving the lever until it comes into contact with a stop which sets the finished size of the work. Any change of size required is effected by altering the initial setting of a control wheel. This method of adjustment, however, is not sufficiently accurate for the plunge grinding of the small valves and pistons of high-pressure hydraulic systems such as are used for the controls of aircraft, which must allow no leakage of the operating fluid even at very high pressures.

To insure the accuracy needed in such valves, a micrometer stop has been devised by Arthur Scrivener, Ltd., Tyburn Road, Birmingham, England. It is shown in position on a Scrivener No. 1 centerless grinder in Fig. 4, and Fig. 5 shows the hand push-feed used to insert and withdraw the components, some of which can be seen in the same illustration. These small parts consist of a shank $1^1/_2$ in. long, on which are two enlargements, forming pistons, which are $^1/_4$ in. in diam. They are ground in five or six passes, according to the finish desired, the first pass removing 0.004 in. and the last pass 0.0001 in., to a final tolerance of 0.000025 in. for size, roundness, and parallelism. No subsequent lapping is necessary.



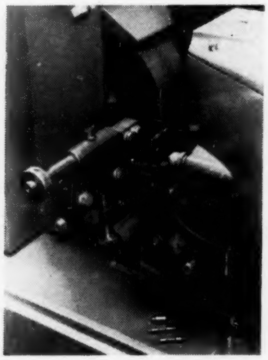
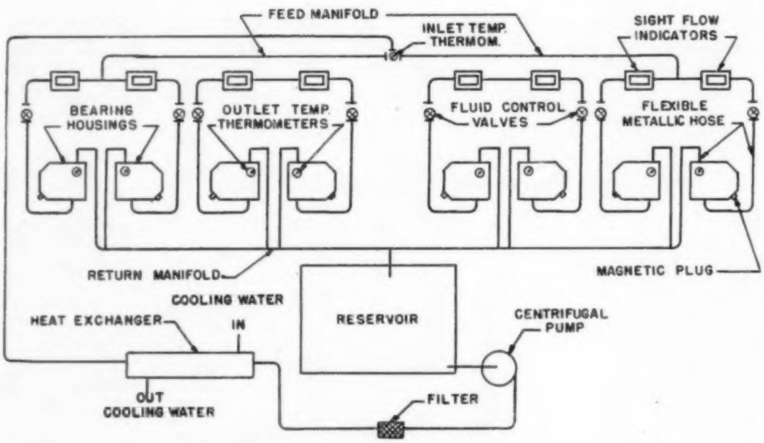


Fig. 4 *Left:* Micrometer stop on Scrivener No. 1 centerless grinder

Fig. 5 *Right:* Hand feed for plunger grinding the hydraulic-system components shown on base of machine

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings



Fluid-transfer system which was used to supply a continuous flow of sample fluid to each of eight bearings mounted in individual housings

Lubrication

Effect of Combustion-Resistant Hydraulic Fluids on Ball-Bearing Fatigue Life, by H. V. Cordiano, E. P. Cochran, Jr., Assoc. Mem. ASME, and R. J. Wolfe, New York Naval Shipyard, Brooklyn, N. Y. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-21** (multilithographed; available to August 1, 1956).

Phosphate ester, phosphate-ester base, and water-glycol base combustion-resistant fluids and a petroleum oil were investigated to determine the relative effects of the fluids, used as flood lubricants, on the life of angular-contact ball bearings.

Bearing life was lower in the combustion-resistant fluids than in oil, ranging from 58 per cent of the life in oil for the phosphate ester, to six per cent for the water-base fluid. Fatigue failures of the bearing races were prevalent for all fluids and additional investigations are required to determine the causes of the wide variation in bearing life in the various fluids.

Operating Characteristics of High-Speed Bearings at High Oil-Flow Rates, by C. C. Moore and F. C. Jones, General Electric Company, West Lynn, Mass. 1955 Joint ASME-ASLE Lubrication Conference Paper No. **55—LUB-10** (multilithographed; available to August 1, 1956).

Using 1005 petroleum oil as a lubricant, 202, 203, and 204-size ball bearings were operated in a speed range of between 0.6 to 1.7×10^6 DN value. Under lightly loaded conditions, oil-flow rates were varied between 1 and 500 range while friction power, oil-inlet, and outer-race temperature were measured at speeds between 30,000 and 100,000 rpm.

The conclusions of this study are as follows:

1 Within the scope of this study small high-speed bearings can best be lubricated by cross-feed or puddling techniques. Jet and mist lubrication were unsuccessful.

2 Friction power is more a function of speed and bearing size than of oil flow.

3 Increasing the oil-flow rate lowers the outer-race temperature but increases the total friction power being created by the bearing.

4 High oil flows will cool a bearing with only a relatively small increase in friction power.

High-Temperature Bearing Operation in the Absence of Liquid Lubricants, by S. S. Sorem and A. G. Cattaneo, Mem. ASME, Shell Development Company, Emeryville, Calif. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-17** (multilithographed; available to August 1, 1956).

Attempts were made to operate single-row, deep-groove, steel-cage ball bearings at 10,000 rpm and 600 F with a radial load of about 30 lb in the absence of any liquid lubricant.

Examination of these bearings after short periods of operation indicated that the abrasive effect of metal oxides formed at elevated temperatures played a major role in their destruction. Removal of oxygen from the environment of the bearing eliminated most of the abrasive wear and permitted a substantial extension of bearing life. Experimentally blanketing the running bearing with an inert gas effectively reduced oxide formation but the most attractive solution to this problem appeared to be the use of a reducing atmosphere of air and hydrocarbon vapor. The addition of sufficient jet-engine fuel (JP-4) to the bearing housing to maintain an air-fuel ratio in the range of seven to 10 in the bearing surrounding atmosphere was used in much of the subsequent work.

Having minimized the contribution of oxidation to the failure mechanisms encountered with dry-running bearings, scuffing, particularly between the rolling elements and their cage, appeared as the next most destructive mechanism. For the prevention of scuffing the application of conventional extreme pressure films or boundary-lubrication agents by the use of vapor-phase additives or by bearing pretreatment has been investigated. Bearings pretreated with sulphur have subsequently been operated with a reducing vapor blanket up to 60 hr at 10,000 rpm and 600 F without appreciable damage to the rolling and sliding surfaces.

Thermal Aspects of Galling of Dry Metallic Surfaces in Sliding Contact, by F. F. Ling, Mem. ASME, and E. Saibel, Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-4** (multilithographed; available to August 1, 1956).

The phenomenon of galling or seizing of metals is believed to be, in general, a function of the thermal and mechanical conditions under which the metallic surfaces are rubbed together. For polished surfaces, under ideal dynamic conditions, i.e., conditions where the surfaces are de-

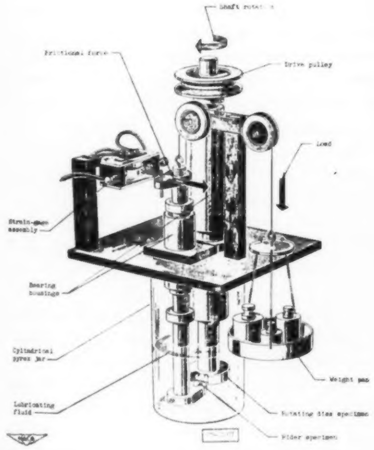
void of appreciable oscillations in the direction normal to the surfaces, thermal aspects of galling predominate. Galling due to thermal conditions is viewed as that condition where the tips of surface asperities weld together by recrystallization welding and are then sheared apart.

The galling criterion, relating normal load, velocity, and time of rubbing, is established theoretically. The result compared favorably with experience.

Difluorodichloromethane as a Boundary Lubricant for Steel and Other Metals, by S. F. Murray, R. L. Johnson, and M. A. Swikert, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-2** (multilithographed; available to August 1, 1956).

This paper describes experiments to determine the ability of difluorodichloromethane to lubricate various metals of interest for bearing surfaces in turbine engines. The investigation was carried out at the NACA Lewis Flight Propulsion Laboratory. A kinetic-friction apparatus having a hemispherical specimen sliding on a rotating disk was operated in an atmosphere of difluorodichloromethane. The study of various materials included combinations of steel types and hardnesses and possible cage materials on hardened steel.

After a brief run-in period at low speeds and light loads, friction force was measured at a sliding velocity of 120 fpm and with a load of 1200 grams (initial Hertz surface stress 158,000 psi). The data reported were obtained at room temperature.



Schematic diagram of friction apparatus for studying boundary lubrication by gases. Pyrex jar shown was used for liquid lubricants; for gaseous lubricants, jar was replaced with an inconel pot.

Difluorodichloromethane was most effective in lubricating steel surfaces when both specimens were of similar hardness. Modified H-monel sliding on hardened tool steel was one of the more effective metal combinations for lubrication with difluorodichloromethane. The method and conditions of application are very critical in lubrication by gaseous materials.

Further research data are necessary in order to specify means for assuring successful gaseous lubrication in practical mechanisms.

Journal-Bearing Performance for Combinations of Steady, Fundamental, and Low-Amplitude Harmonic Components of Load, by G. S. A. Shawki, Cairo University, Cairo, Egypt. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-15** (multilithographed; to be published in Trans. ASME; available to August 1, 1956).

Performance characteristics of a full journal bearing were obtained for load waves composed of low-amplitude second, third, and fourth-harmonic components superposed on the fundamental component. Value of the amplitude ratio P_n/P_1 used in the tests was of the order of 0.3 to 0.4. The study included the investigation of two extreme values of the phase relationship and also the effect of deliberately-imposed steady-load component adjusted to give maximum or minimum loads in the cycles approximately equal to zero.

The most striking phenomenon encountered in the tests was the appearance of the subharmonic critical-speed ratio at a value which corresponded to the harmonic component involved, namely, in the neighborhood of 0.5/2, 0.5/3, and 0.5/4 for second, third, and fourth harmonics, with journal center loci comprising two, three, and four loops, respectively. An explanation for this feature of behavior is put forward.

Value of the phase relationship was found not to affect appreciably the presence of the subharmonic critical-speed ratio though it was shown to have, in general, some influence on the bearing performance.

Critical increase in maximum eccentricity ratio was accompanied, at the fundamental critical-speed ratio, by some related increase in friction.

Owing to the improvement in the relative load-carrying capacity of the bearing after the fundamental critical-speed ratio, for the load waves tested, bearing design based on a steady load equal to the maximum load in the cycle seemed to be of adequate safety for values of the speed ratio greater than about 0.7 to 0.8.

This superposition of the steady-load component affected the performance characteristics in a manner similar to that shown by sinusoidally fluctuating loads. For certain waves, with the intentionally-imposed steady-load component, some tendency to journal center whirl was noted. This was attributed to some stimulus to no-load whirl brought in by the form of the wave. With the load fluctuation presented, no significant relative change in the bearing behavior was experienced at the subharmonic critical-speed ratio.

Studies in Lubrication XI: Slider Bearing With Transverse Curvature; Exact Solution, by A. S. C. Ying, A. Charnes, and E. Saibel, Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-13** (multilithographed; to be published in Trans. ASME; available to August 1, 1956).

An exact solution is developed for the Reynolds equation in the hydrodynamical theory of slider-bearing lubrication with side leakage for film thickness varying exponentially both in the direction of motion and symmetrically perpendicular to this direction.

This solution is in the form of a rapidly convergent series from which calculations for the pressure distribution, total bearing load, frictional force, and the like, may be made conveniently for all length-to-width ratios, all entrance-to-exit clearance ratios, and all center-to-side clearance ratios.

The results which were obtained previously by the perturbation method are shown to be quite accurate for small ratios of center-to-side clearance and for larger ratios the error of the perturbation method is calculated. In fact, the present exact solution turns out to be as convenient to apply as the former approximate one and is recommended for practical consideration.

Temperature Effects in Hydrostatic Thrust-Bearing Lubrication, by W. F. Hughes, Assoc. Mem. ASME, and J. F. Osterle, Assoc. Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-11** (multilithographed; available to August 1, 1956).

The hydrostatic thrust bearing is analyzed under adiabatic flow conditions for both an incompressible (oil) and a compressible (air) lubricant.

Expressions for the pressure and temperature distributions, load capacity, and frictional torque are obtained. For the incompressible case the load capacity

undergoes appreciable deviation from the isothermal behavior with variations in angular velocity. However, for the compressible lubricant, the load capacity differs only slightly from isothermal behavior, and is nearly constant with variations in angular velocity.

The Rheostatic Thrust Bearing, by F. Osterle and E. Saibel, Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-6** (multilithographed; available to August 1, 1956).

The static thrust bearing using grease as the lubricant is analyzed. The grease is treated as an ideal Bingham plastic. Load capacity and frictional torque are calculated and the results compared with the static thrust bearing using oil as the lubricant.

Both the load capacity and frictional torque are found to be greater for the grease bearing by an amount which can be significant.

Density-Temperature-Pressure Relations for Liquid Lubricants, by H. A. Hartung, The Atlantic Refining Company, Philadelphia, Pa. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-7** (multilithographed; to be published in Trans. ASME; available to August 1, 1956).

Recently published data on the density of lubricating fluids have been treated to separate the effects of temperature and pressure.

Correlations are developed which reproduce the original data within less than one per cent in most cases for petroleum fractions, pure hydrocarbons, polymer-blended oils, and commercial lubricants. It is expected that the relations found will apply to all liquid lubricants which are principally petroleum hydrocarbons.

Density at any temperature up to 425 F and at pressures up to 80,000 psi can be found from the density at room temperature and atmospheric pressure and the viscosity at 10 F.

Prediction of the Viscosity of Liquid Lubricants Under Pressure, by H. A. Hartung, The Atlantic Refining Company, Philadelphia, Pa. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB 18** (multilithographed; available to August 1, 1956).

A method is proposed for predicting the pressure viscosity isotherms of liquid lubricants at 100 and 210 F up to 100,000 psi. It is based on graphical correlation of data from the ASME Pressure Viscosity Report, and in most cases reproduces those data within about 20 per cent. Data from other sources check within this range as well.

The method loses accuracy for low-viscosity oils (less than about four centistokes at 210 F), particularly if they have very high-temperature coefficients of viscosity (less than −100 VI). It is suitable for pure hydrocarbons, normal petroleum fractions, polymer-blended oils, and commercial lubricants.

Data required to make the prediction are atmospheric-pressure densities and viscosities at 100 and 210 F.

Physico chemical Investigation of Engine-Oil Performance, by A. Bondi, S. J. Beaubien, and H. Diamond, Shell Development Company, Emeryville, Calif. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-5** (multilithographed; available to August 1, 1956).

A systematic analysis of engine-oil deterioration and related phenomena has been accomplished by correlating pertinent oil properties with results from appropriate engine tests.

Engine conditions were so selected that performance would be determined largely by one, or at most, two factors and comprised: (*a*) A cycling sequence at low temperatures characteristic of city driving; (*b*) moderate-temperature operation resembling winter driving on the highway; and (*c*) hot diesel operation. Oil properties included deflocculating ability, catalyzed-oxidation rate, and corrosivity to bearings caused by oil oxidation. They were measured over a sufficiently wide temperature range so as to cover conditions prevailing in all regions within the engine.

With typical commercial fuels and at usual (relatively high) additive concentrations, cleanliness in spark-ignition engines at low and moderate temperatures requires the disposal of partial fuel-combustion products. High-temperature (gasoline and diesel) engine cleanliness is governed largely by the retardation of oil oxidation and dispersal of the eventual oil-deterioration products. Nearly precise prediction of (copper-lead) bearing corrosion in test engines may be obtained from a facsimile bearing installed in an oxidation cell, operated at engine-bearing temperatures and at the low degrees of oxidation generally found in crankcase oils.

These correlations help to interpret engine results and establish mechanisms but do not furnish an ultimate criterion for oil performance. Over-all evaluation can be conducted only in the engine, for it alone assesses simultaneously under actual operating conditions such diverse functions as detergency and prevention of corrosion and wear.

Finite Journal Bearings With Arbitrary Position of Source, by J. V. Fedor, Assoc. Mem. ASME, Lehigh University, Bethlehem, Pa. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-14** (multilithographed; to be published in Trans. ASME; available to August 1, 1956).

By using different mathematical methods, Muskat and Morgan's theory of force-feed lubrication is put in a compact, convenient form. The first derivative is neglected in the solution of Reynolds homogeneous equation to gain mathematical simplicity for the pressure distribution. Sommerfeld boundary conditions are used and no restriction on length of bearing is made.

Explicit equations are derived for the characteristics of finite journal-bearing systems. Values calculated compare with published results when the source is at the crown of the bearing. It is estimated that the solution will give satisfactory results for eccentricity ratios up to 0.4. For relatively short bearings the eccentricity ratio can be extended to higher values.

The Effects of Pressure and Temperature on the Viscosity of Lubricants—Part II, Application of Vogel's Equation, by R. B. Dow, Mem. ASME, Bureau of Ordnance, Navy Department, Washington, D. C. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-19** (multilithographed; available to August 1, 1956).

This analysis has extended the earlier study of the ASTM-Walther method to include an examination of the applicability of the Vogel equation to reproduce the viscosity-temperature-pressure experimental data of 21 of the 23 paraffinic and naphthenic-base oils comprising two broad series of investigations. The parameter A of the equation has been found to be independent of both the sample and the pressure for paraffinic-type oils, but for naphthenic oils it was observed that A was a function of pressure. However, by taking an average A over the pressure range for each naphthenic sample a mean value could be used in the Vogel equation which permitted the computation of viscosity to within an average of 20 per cent of the experimental viscosities. The parameter B was found to depend linearly on pressure for both types of oils, and the slope of the B-p curves correlates well with the molecular weights of the samples.

A Vogel equation has been derived

with a pressure correction which allows the computation of viscosity, over a pressure range of 50,000 psi at temperatures from 0 to 98.9 C, within an average error of from 15 to 20 per cent. The ASTM chart is considered to be preferable to the Vogel chart over the range 0 to 218.3 C, inasmuch as deviations from the linear isobars are less serious at the extremes of temperature. Within these limitations the ASTM and Vogel charts are considered to be equivalent as regards their applicability. Likewise, the Walther equation is more reliable for computation at the extremes of temperature, but over a range from 0 to 98.9 C the Vogel equation is more convenient to use and its parameters are more readily correlated with the molecular weights of the oils. Both the Walther and Vogel equations are more satisfactory for computing the viscosity of oils under pressure than any other method which has been proposed.

The Lubrication of Friction Drives, by T. B. Lane, Shell Research Ltd., Chester, England. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-3** (multilithographed; available to August 1, 1956).

Friction drives find frequent application where continuous variation in the speed ratio of coupled shafts is required. In order to insure high frictional forces between the power-transmitting elements, they are heavily loaded and lubricants giving a high coefficient of friction must preferably be used.

An apparatus is described in which the frictional force between two rotating balls pressed together is measured in the region of speeds about the nominal rolling condition. The frictional behavior of the system is discussed and it is shown that in the contact area there is relative sliding between the surfaces even when the balls are rolling together. This characteristic is a common feature of friction drives and so the apparatus has been used to investigate the effect of lubricants on the coefficient of friction.

The conclusion is reached that the temperature coefficient of viscosity of the lubricant used plays a large part in determining the efficiency of the friction drive, a large value being beneficial.

Predicting Performance of Starved Bearings, by D. F. Wilcock, Mem. ASME, General Electric Company, Schenectady, N. Y. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-9** (multilithographed; available to August 1, 1956).

This paper outlines a procedure for determining the performance of starved bearings.

In certain cases, such as wick-fed and oil-ring bearings, the rate of oil feed must be determined empirically by experiment. An extension of this procedure permits the estimation of the time of operation before failure of bearings whose oil supply has been cut off. It is known from experiment that this time may be as high as several minutes.

Analysis of Partial Journal Bearings Under Steady Loads, by J. C. Lee, Armour Research Foundation, Chicago, Ill. 1955 Joint ASLE Lubrication Conference paper No. **55—LUB-1** (multilithographed; available to August 1, 1956).

The bearing analysis covered by this paper was carried out as one part of a comprehensive investigation of the railroad freight-car hotbox problem, which was conducted by the Armour Research Foundation for the Association of American Railroads. As previous analyses of partial bearings included in the literature have not been extended to the large-clearance and high-eccentricity-ratio conditions sometimes met in railroad practice, additional analysis applying to these specific conditions was required.

Solution of Reynolds equation has been obtained for partial bearings of infinite length through use of both analytical and numerical methods. The solution is based upon assumption of the existence of cavitation in the oil film in the region where negative pressures normally are encountered.

Computed performance curves are presented for a wide range of bearing parameters, including use of inadequate oil supply to the bearing.

Varieties of Shaft Disturbances Due to Fluid Films in Journal Bearings, by B. L. Newkirk, Fellow ASME, Consulting Engineer, Schenectady, N. Y. 1955 Joint ASME-ASLE Lubrication Conference paper No. **55—LUB-12** (multilithographed; available to August 1, 1956).

The disturbances heretofore called "shaft whipping," "oil whip," or "oil-film whirl" have been recognized and discussed for some 30 years. Recently, interest has become active and certain apparent inconsistencies of reported behavior have come to light. For example, the disturbance appears with some rotors that run at speeds below their lowest critical speeds and, in other cases, it does not appear unless the rotor runs at more than twice its lowest critical speed. In the field, some rotors exhibiting the disturbance can be quieted by warming up the oil supplied to the bearing, and in other cases, cooling the oil supply is effective.

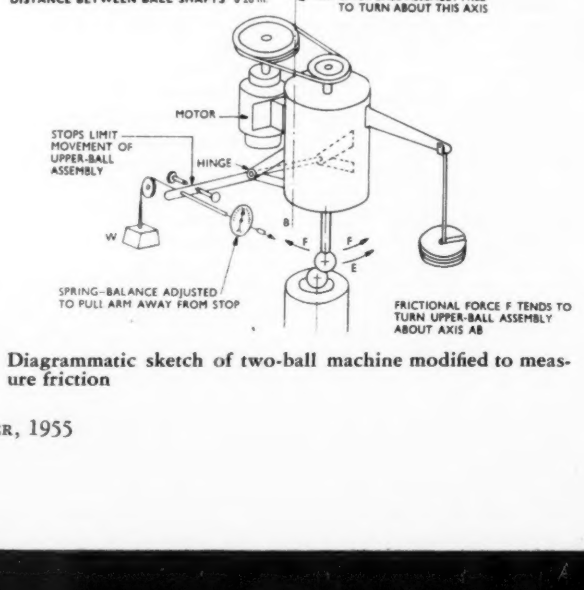
There are other diversities of behavior which are discussed in the paper that indicate a complex situation requiring clarification.

Petroleum

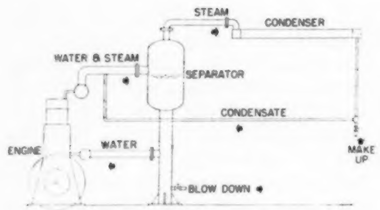
Ebullition Cooling of Gas Engines, by G. O. Bates, Mem. ASME, J. E. English, and G. M. Franklin, Assoc. Mem. ASME, Stanolind Oil & Gas Company, Tulsa, Okla. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-18** (multilithographed; available to July 1, 1956).

The ebullition system is defined as a method for cooling internal-combustion engines by boiling water in the engine jackets.

With this system a mixture of water and steam from the engine enters a separator. Steam flows to an elevated condenser from which condensate is returned by gravity to the fluid stream entering the separator. This mixing ahead of the separator provides uniform temperatures in case the condensate has been subcooled. There are no pumps because



Diagrammatic sketch of two-ball machine modified to measure friction



A simplified ebullition cooling system with the engine, the separator, and the steam condenser. A mixture of water and steam from the engine enters the separator. Steam flows to an elevated condenser from which condensate is returned by gravity to the fluid stream entering the separator. This mixing ahead of the separator provides uniform temperatures in case the condensate has been subcooled.

all circulation is maintained by the difference in densities between the water in the separator and the mixture of water and steam in the jackets.

The ebullition system requires less heat-transfer surface and a smaller cooling-air fan than a comparable forced-circulation water system because of the greater temperature differences and higher heat-transfer rates that result when condensing steam.

Power requirements are less because of the smaller fan and driver and the elimination of the engine-jacket water pump. Operating costs are lower for the same reasons.

In this paper relationships of power requirements, equipment prices, and installed costs for ebullition systems and conventional forced-circulation water systems are shown graphically.

Satisfactory performance over an initial operating period of ten months is reported for the cooling equipment and engines on five units equipped with ebullition systems. Observations on those units during the same period indicate that engine maintenance will be less than for similar engines with conventional cooling.

In view of its economy, simplicity, and satisfactory functional performance, ebullition cooling is expected to supersede eventually conventional water cooling.

The Operation of Compressor Cylinders Without Cooling Water, by J. L. Gallagher and H. W. Evans, Sinclair Oil & Gas Company, Tulsa, Okla. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-17** (multilithographed; available to July 1, 1956).

It has been a tradition with the natural-gasoline industry to cool compressor cylinders with water.

Several years ago it became necessary to replace the water header to the compressor cylinders at one of the Sinclair Oil & Gas Company plants. In order to avoid a shutdown or the use of temporary piping, the compressor cylinders were operated without cooling for three days. Compressor performance was satisfactory and no damage was found.

Later, during a study to simplify operation and reduce expenses, tests were conducted on the operation of compressor cylinders without cooling water. Results were highly satisfactory, and today all the company's new compressor installations are made without cooling water.

By the use of test data and thermodynamics, it is pointed out that there is no practical difference in compressor capacity, and the savings in equipment, installation cost, and maintenance more than justify the small additional horsepower required to operate without cooling water.

High-Temperature Stability of Insulating and Refractory Castables in Reducing and Oxidizing Atmospheres, by C. M. Vogrin and H. Heep, The M. W. Kellogg Company, New York, N. Y. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-31** (multilithographed; available to July 1, 1956).

Beginning with the installation of a castable lining in a regenerator of a fluid catalytic-cracking unit in 1946, the authors' company became interested in the use of castables as a means for temperature reduction and erosion protection. Encouraged by successful service coupled with the growing acceptance by industry of castables it was decided to investigate the possible application of castable linings for services involving temperatures up to 2400 F in a reducing atmosphere of CO, H_2, CO_2, CH_4, and H_2O.

Conclusions were as follows:

When selecting commercial refractory castables, careful consideration must be given to all possible service conditions. It is not enough to note the maximum service temperature. Cycle temperature variations during operation, type of atmosphere, and expected frequency of shutdown with attendant cooling influence decisively the choice of a castable.

Information handed out by reputable manufacturers of commercial castables was found fairly correct, but incomplete. Therefore appropriate tests are advisable whenever castables have to be specified for new service conditions. The unexpected disruptive carbon deposits on catalytic iron particles from the decomposition of CH_4 at 1750 to 1800 F proved this point.

The ASTM specifies an atmosphere of 100 per cent CO for the standard disintegration tests. An atmosphere of CO alone should be a rare occasion in any process. Indications are that a certain minimum percentage, possibly more than 50 per cent of CO, is required to produce such damage. More work is desirable to determine exactly the critical range of CO concentrations.

The maximum service temperature as recommended by reputable manufacturers of commercial castables is reliable. Materials with ratings up to 2000 F will not fail even if soaked at the maximum temperature. However, ratings from 2250 to 3000 F must be considered more or less as hot-face temperatures.

Castables containing high early strength Portland cement as hydraulic binder can be used without limitations up to 1300 F. Regarding service at higher temperatures, it must be kept in mind that during subsequent cooling and shutdown periods some instability exists due to reaction of dehydrated lime with the surrounding atmosphere or to mineral inversions. Excessive hydration during application increases this instability. Portland cement mixes, however, offer good resistance against carbon disintegration.

Castables containing Lumnite (calcium-aluminate) cement combined with suitable aggregates possess temperature stability up to 2250 F. Service environment containing high percentage of CO (about 50 per cent and more) and CH_4 will cause carbon disintegration in a temperature range of 900 to 1700 F. The reaction is catalyzed by the high iron content of the Lumnite cement.

Castables for hot-face temperatures of 2500 to 3200 F require practically iron-free (less than 1 per cent) calcium-aluminate cement for reasons of temperature stability. These castables, if mixed with an equivalent inert aggregate, possess also the greatest stability against various service environment.

In selecting a castable material for a vessel lining, check for substances in the castable which might be a catalyst for undesirable reactions or which react chemically with the service environment in a way to cause damage to the liner itself or to substances inside the contained equipment, for instance, catalysts.

Tool-Joint Thread Lubricant, by C. H. Dragert Company, Inc., Dallas, Texas. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-28** (multilithographed; available to July 1, 1956).

Use of metallic powders in thread compounds is explained and reviewed. Plas-

tic flow of metals under conditions of extreme shear and pressure is indicated as the effective principal in metallic thread compounds or "dopes."

Fuels Technology

Future Trends in Stoker Design, by E. C. Miller, Mem. ASME, Riley Stoker Corporation, Worcester, Mass. 1955 ASME Joint Fuels Conference paper No. **55—FU-1** (multilithographed; available to August 1, 1956).

AUTOMATION is the newest trend in stoker design.

New designs offered by stoker manufacturers are aimed at reducing operating efforts and eliminating the drudgery and dirt so long associated with stoker firing. Complete mechanization of coal-and-ash handling together with improvement in combustion controls reduce operating costs and improve reliability and availability of equipment. In addition to better operating conditions, new designs enhance the appearance and improve the efficiency of firing aisles.

Automatic control of coal supply, combustion, and ash removal is essential in order for stoker firing to be as attractive as oil firing. The newest designs by the stoker manufacturers indicate that these requirements will be met.

Applied Mechanics

The Nonlinear Bending of Thin Circular Rods, by H. D. Conway, Cornell University, Ithaca, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-24** (in type; to be published in the *Journal of Applied Mechanics*).

Two examples of the nonlinear bending of thin circular rods are discussed using the Bernoulli-Euler equation, which states that the change of curvature of a rod is proportional to the bending moment producing it.

Numerical results are presented.

Large Deflections of Elliptical Plates, by N. A. Weil, The M. W. Kellogg Company, New York, N. Y., and N. M. Newmark, Mem. ASME, University of Illinois, Urbana, Ill. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-2** (in type; to be published in the *Journal of Applied Mechanics*).

A SOLUTION is obtained by means of the Ritz method for the "large-deflection" problem of a clamped elliptical plate of constant thickness, subjected to a uniformly distributed load.

Two shapes of elliptical plate are treated, in addition to the limiting cases of the circular plate and infinite strip, for which the exact solutions are known. Center deflections as well as total stresses at the center and edge decrease as you proceed from the infinite strip through the elliptical shapes to the circular plate, holding the width of the plates constant. The relation between edge stress at the semiminor axis (maximum stress in the plate) and center deflection is found to be practically independent of the proportions of the elliptical plate. Hence the governing stress may be determined from a single curve for a given load on an elliptical plate of arbitrary dimensions, if the center deflection is known.

Theory of Plastic Buckling of Plates and Application to Simply Supported Plates Subjected to Bending or Eccentric Compression in Their Plane, by P. P. Bijlaard, Cornell University, Ithaca, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-8** (in type; to be published in the *Journal of Applied Mechanics*).

AFTER some general considerations on plastic buckling of plates, the plastic-buckling stresses are calculated for long plates, subject to longitudinal bending or eccentric compression in their plane, and simply supported at their unloaded edges.

The solutions are based on the author's theory of plastic plate buckling and are obtained by reducing the governing partial differential equation to ordinary finite-difference equations. Second-order finite differences are used, with a spacing equal to one ninth of the plate width.

A simple design formula is presented for the plastic reduction factor with which the elastic-buckling stress has to be multiplied for obtaining the plastic-buckling stress.

A Theory of the Yield Point and the Transition Temperature of Mild Steel, by F. Forscher, Westinghouse Electric Corporation, Pittsburgh, Pa. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-42** (in type; to be published in the *Journal of Applied Mechanics*).

EXPERIMENTAL results indicate the dependence of the yield-point phenomenon of mild steel on temperature, strain rate, duration of stress, and stress state.

This paper proposes a yield criterion which can account for these variables. The theory is developed on the basis of a "structural" model, by which the behavior of microscopic and submicroscopic elements is idealized. The theory postulates as yield criterion a critical number of relaxation centers (active Frank-Read sources) or, equivalently, a critical size of relaxation centers. The transition-temperature phenomenon is considered to be the result of an inhibition of yielding (upper yield point) by means of geometry, temperature, and/or strain rate. A relation is given which expresses its dependence on the state of stress and strain rate.

Asymmetrical Bending of a Cylindrically Aeolotropic Tapered Disk, by E. S. Baclig and H. D. Conway, Cornell University, Ithaca, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-20** (in type; to be published in the *Journal of Applied Mechanics*).

VARIATIONS of thickness, anisotropy, and asymmetry of loading usually tend to increase the mathematical difficulty of obtaining solutions to the small-deflection problems of plate bending. However, for the bending of a cylindrically aeolotropic disk twisted about its diameter and having a certain thickness variation, it is possible to obtain a relatively simple solution in closed form.

This solution is presented, numerical results being given for oak and for isotropic material.

Theoretical Determination of Rigidity Properties of Orthogonally Stiffened Plates, by N. J. Huffington, Jr., Assoc. Mem. ASME, Virginia Polytechnic Institute, Blackburg, Va. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-12** (in type; to be published in the *Journal of Applied Mechanics*).

ANALYSIS of bending and buckling of orthogonally stiffened plates may be simplified by conceptually replacing the plate-stiffener combination by an "equivalent" homogeneous orthotropic plate of constant thickness. This procedure requires the determination of the four elastic rigidity constants which occur in the theory of thin orthotropic plates.

Methods are presented whereby these quantities may be determined analytically in terms of the elastic constants and geometrical configuration of the component parts of the structure.

Bending Creep and Its Application to Beam-Columns, by L. W. Hu, The Pennsylvania State University, University Park, Pa., and N. H. Triner, United Aircraft Corporation, East Hartford, Conn. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-21** (in type; to be published in the *Journal of Applied Mechanics*).

A PROCEDURE for evaluating the creep deflection of members subjected to bending moment is suggested. The application of the suggested procedure to beam-columns is given. For checking the validity of the proposed method, an in-

vestigation on the creep behavior of beam-columns of magnesium alloy FS1-F at 260 F was conducted.

The comparison of the experimental results with the theoretical predictions was found satisfactory.

The Load-Carrying Capacity of Circular Plates at Large Deflection, by E. T. Onat, Yenisehir, Ankara, Turkey, and R. M. Haythornthwaite, Brown University, Providence, R. I. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-14** (in type; to be published in the *Journal of Applied Mechanics*).

This paper presents an approximate analysis for the load-carrying capacities of initially flat circular plates under various loading and edge conditions and subjected to slowly increasing load. As a plate deforms, the carrying capacity is increased as a result of favorable changes in geometry.

In this study, the load capacity after finite deflection is estimated by assuming a velocity field based on the boundary conditions and on the incipient velocity field of the flat plate, the analysis being made for a rigid plastic, nonstrain-hardening material that yields according to the maximum shear-stress criterion.

In several cases the results obtained compare favorably with test data for mild-steel plates. However, for very thin plates, better agreement is obtained by means of a purely membrane-type analysis, which also is presented.

Displacements in an Elastic-Plastic Cylindrical Shell, by P. G. Hodge, Jr., Mem. ASME, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-4** (in type; to be published in the *Journal of Applied Mechanics*).

A reinforced cylindrical shell which is loaded with a uniform excess external radial pressure can support a load considerably greater than the elastic limit. While several recent investigations have been concerned with finding the collapse load of the shell, no attention has been paid to the corresponding deformations. Although rigid-plastic theory is sufficient to determine the collapse load, the more complex elastic-plastic theory must be used in investigating the displacements.

In this paper the elastic-plastic problem is stated for an ideal sandwich shell, and the stresses and deformations are computed for a particular example. Since the computations are found to be quite laborious, an approximate technique, applicable to all shells, is developed.

The paper closes with some comments on the relation between the theoretical results and the behavior to be expected in real shells.

Combined Stress Tests in Plasticity, by Aris Phillips, Mem. ASME, Yale University, New Haven, Conn., and Lloyd Kaechele, Stanford University, Stanford, Calif. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-15** (in type; to be published in the *Journal of Applied Mechanics*).

A substantial number of combined stress tests on thin-walled tubes of aluminum 2S-O are reported. In most of the tests the tubes have been subjected to combined tension and torsion with variable stress ratios. In the last six tests each tube has first been subjected to uniaxial tension until sufficiently deep in the plastic region and then this state of uniaxial stress has been rotated while the magnitude of the principal stresses remained constant.

The purpose of the tests was to get information as to the validity of the incremental theories of plasticity. Results of these tests favor the incremental theories.

The Pattern of Plastic Deformation in a Deeply Notched Bar With Semicircular Roots, by L. Garr and E. H. Lee, Mem. ASME, Brown University, Providence, R. I., and A. J. Wang, Illinois Institute of Technology, Chicago, Ill. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-23** (in type; to be published in the *Journal of Applied Mechanics*).

Plastic deformation in a notched bar with deep semicircular roots pulled in plane strain is determined theoretically. The finite deformation is analyzed according to plastic-rigid theory. The motion is unsteady, and the velocity field at any instant is given in terms of the current geometry of the deformed free surface.

A graphical step-by-step method is used to determine the deformation of a square grid scribed on the undeformed cross section. The deformed pattern details the regions of large plastic strain, and may be useful in considering the initiation of fracture cracks.

Analysis of Short Thin Axisymmetrical Shells Under Axisymmetrical Edge Loading, by G. Horvay, Mem. ASME, J. S. Born, General Electric Company, Schenectady, N. Y., and C. Linkous, General Electric Company, Fort Wayne, Ind. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-3** (in type; to be published in the *Journal of Applied Mechanics*).

On the basis of recent work by Hildebrand, formulas are established for the effects of axisymmetrical edge moments and edge shears on short shells of variable wall thickness and variable meridional curvature. While the formulas are inferior in accuracy to those developed for bolted flange assemblies by Waters, Rossheim, Wesstrom, and Williams, in simplicity of use and speed of calculations they are on a par with the well-known Geckeler formulas, without being subject to many of the limitations of the latter.

The formulas are particularly suited for the analysis of the tapered-hub portion of a flanged shell. Other uses are also obvious.

Particular applications to redundant-shell (torus-type) problems will be given in a separate paper.

On Axially Symmetric Bending of Nearly Cylindrical Shells of Revolution, by R. A. Clark, Case Institute of Technology, Cleveland, Ohio, and E. Reissner, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-18** (in type; to be published in the *Journal of Applied Mechanics*).

The words "nearly cylindrical" are used in this paper to describe a thin elastic shell of revolution which is such that (*a*) the maximum variation of the radial dimension is small compared to the average radial dimension, and (*b*) the rate of change of the radial dimension with respect to the axial dimension is small compared to unity. For any particular type of loading a nearly cylindrical shell may or may not exhibit a behavior similar to that of a shell which is exactly cylindrical.

The purpose of this paper is to demonstrate this fact and to present a method for obtaining approximate solutions for the stresses and deflections in either event. The method involves a perturbation procedure based on the assumption that all desired quantities can be represented as expansions in powers of two small parameters. The procedure leads to a set of linear differential equations with constant coefficients, which may be solved successively.

Stress Functions for Rotating Plates, by P. G. Hodge, Jr., Mem. ASME, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-5** (in type; to be published in the *Journal of Applied Mechanics*).

The general theory of two-dimensional bodies subjected to body forces is well known. However, except for a few examples in which gravity is the body

force, and various examples of rotationally symmetric rotating disks, comparatively little appears to have been done with this theory.

The present paper applies the theory to the general case of a thin plate rotating about an axis in its plane. As specific examples, a circular plate rotating about a diameter, and a triangular plate rotating about a side are considered. For the case of a long thin triangle, the result is shown to reduce to that previously obtained by using an extension of beam theory.

Studies in Dynamic Photoelasticity, by M. M. Frocht, Mem. ASME, Illinois Institute of Technology, Chicago, Ill., and P. D. Flynn, Assoc. Mem. ASME, General Electric Company, Schenectady, N. Y. 1955 ASME Diamond Jubilee Annual Meeting paper No. **55—A-1** (in type; to be published in the *Journal of Applied Mechanics*).

Equipment and techniques are described for obtaining dynamic photoelastic-stress patterns from arbitrary lines in plane-stress systems by means of streak photography. Streak-type stress patterns of such lines were obtained which provide continuous records throughout the entire period of impact (of the order of milliseconds) at times of exposure of $^2/_3$ microsec. This is thirty times faster than the time of exposure (20 microseconds) obtained by Tuzi and Nisida in 1935. Dynamic photoelastic-stress patterns showing stress-wave propagation are given for a bar struck axially by a rigid mass, and these patterns show that a uniform state of stress was obtained.

Theoretical stress patterns based on the Boussinesq solution are in essential agreement with the experimental results.

A New Approach to the Analysis of Large Deflections of Plates, by H. M. Berger, Office of Naval Research, Washington, D. C. 1955 ASME West Coast Applied Mechanics Conference paper No. **55—APM-36** (in type; to be published in the *Journal of Applied Mechanics*).

Simplified nonlinear equations for a flat plate with large deflections are derived by assuming that the strain energy due to the second invariant of the middle-surface strains can be neglected. Computations using the solution of these simplified equations are carried out for the deflection of uniformly loaded circular and rectangular plates with various boundary conditions.

Comparisons are made with available numerical solutions of the exact equations.

The deflections found by this approach are then used to obtain the stresses for the circular plate and the resulting stresses are compared with existing solutions.

In all the cases where comparisons could be made, the deflections and stresses agree with the exact solutions within the accuracy required for engineering purposes.

ASME Transactions for October, 1955

The October, 1955, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

Technical Papers

The Statistical Nature of Friction, by E. Rabinowicz, B. G. Rightmire, C. E. Tedholm, and R. E. Williams. (54—LUB-2)

The Evaluation of Corrosion Resistance for Gas-Turbine-Blade Materials, by W. E. Young, A. E. Hershey, and C. E. Hussey. (54—A-215)

The Influence of Some Chemical and Physical Factors on the Formation of Deposits From Residual Fuels, by P. T. Sulzer. (54—A-171)

Compressibility Deviations for Polar Gases, by N. A. Hall and W. E. Ibele. (54—A-140)

Total Normal Emissivity Measurements on Aircraft Materials Between 100 and 800 F, by N. W. Snyder, J. T. Gier, and R. V. Dunkle. (54—A-189)

Thermal Conductivity and Its Variability With Temperature and Pressure, by L. S. Kowalczyk. (54—A-90)

The Ultrasonic Measurement of Hydraulic Turbine Discharge, by R. C. Swengel, W. B. Hess, and S. K. Waldorf. (54—A-54)

Recent Investigations of the Mechanics of Cavitation and Cavitation Damage, by Robert T. Knapp. (54—A-106)

On the Mechanism of Cavitation Damage, by M. S. Plesset and A. T. Ellis. (54—A-76)

Secondary Flow in Axial-Flow Turbomachinery, by L. H. Smith, Jr. (54—A-158)

Development of a Miniature Electrohydraulic Actuator, by S. Y. Lee and J. L. Shearer. (54—A-196)

Residual Grinding Stresses in Hardened Steel, by H. R. Letner. (54—A-56)

The Determination of Residual Stresses in Hardened Ground Steel, by L. V. Colwell, M. J. Sinnott, and J. C. Tobin. (54—A-52)

Temperature Distribution at the Tool-Chip Interface in Metal Cutting, by B. T. Chao and K. J. Trigger. (54—A-115)

Cutter Design and Application for Face-Milling Cast Iron and Steel, by O. W. Boston and W. W. Gilbert. (54—A-51)

Dynamics in the Inlet System of a Four-Stroke Single-Cylinder Engine, by C. F. Taylor, J. C. Livengood, and D. H. Tsai. (54—A-188)

Steam-Piping Design to Minimize Creep Concentrations, by Ernest L. Robinson. (54—A-186)

Stack Height Required to Minimize Ground Concentrations, by E. W. Hewson. (54—A-211)

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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Steam Turbine-Generator Units

Comment by M. K. Drewry[1]

PLANNING for the future, long a guiding principle of the power industry, prompts careful consideration of the cross-compound turbine.[2]

With system loads doubling about every 10 years, turbine sizes will also probably double that frequently.

For 3600-rpm exhaust blading to provide adequate flow area in the future seems physically impossible. Aside from vital efficiency considerations that deserve increasing study, maintenance and reliability aspects suggest that blade-tip speeds cannot be increased without limit. Erosion is understood to increase with the sixth power of relative blade and water speeds. At this high exponential rate, erosion at only 12 per cent higher blade-tip speed will be doubled. Unreliability is untenable.

That some turbines of 20 years hence will require low-pressure sections of 1200 rpm seems plausible. Their large-diameter spindles, to meet shipment limitations, obviously would require blading in the field. For the same basic blade design, 1200 rpm will afford nine times the capacity of 3600 rpm. Since high pressures and high temperatures positively require 3600 rpm, the cross-compound unit appears almost inevitable.

Unless new "wonder" metals are developed, general acceptance of the cross-compound design, with its many other vital advantages, seems a reasonable expectation.

Comment by Robert L. Reynolds[3]

As the author points out, the cross-compound unit having a 3600-rpm high-pressure element and an 1800-rpm low-pressure element can be economically justified for large-size units where an ample supply of relatively cold circulating water is available. This advantage is derived from the higher over-all efficiency resulting from the reduction in exhaust losses on the larger low-pressure blading.

The author cites the following major disadvantages of the 3600/1800-rpm cross-compound design as compared with the 3600-rpm tandem-compound design:

(*a*) Additional investment.

(*b*) Complexity of two generators instead of one.

(*c*) Greater floor space.

Additional disadvantages of the cross-compound arrangement are as follows:

1 Shipping limitations, which may in some cases necessitate shipping the low-pressure-turbine rotor without part or all of the last row of blades. These blades, or the bladed disk, must then be installed at the station, thus adding to the time required to erect the unit. This shipping problem becomes increasingly difficult when the length of the last rows of blades exceeds 40 in.

2 Size of forgings for 1800-rpm generator. Because of its greater physical size, problems connected with the production of defect-free forgings become more critical. Not only do the larger ingots have greater possibilities for internal voids, but require more drastic forging to consolidate the forging and weld the discontinuities.

The arrangement described by the author materially reduces the floor space required for the cross-compound unit. When conditions permit, this can reduce foundation, crane, and other station costs.

Another advantage of this close-coupled arrangement is the reduction in steam-pressure drop between the high and low-pressure elements. This will result in a slight improvement in turbine effciency.

It is therefore apparent that the close-coupled design reduces some of the disadvantages of the cross-compound unit and thus makes it possible to justify this arrangement in a greater number of cases.

Author's Closure

Low-pressure turbines operating at 1200 rpm, as suggested by Mr. Drewry, offer a possible solution for the design of turbines having the very large capabilities which may some day be required. Economic studies of the many factors involved will determine if their application is justified in the same manner as studies are made today for 1800-rpm low-pressure turbines.

The additional disadvantages of the cross-compound arrangement, as mentioned by Mr. Reynolds, are recognized. The problem of shipping limitations can be, and has been, handled by careful planning and design. Experience with the supercharged cooling of generators has indicated that when larger 1800-rpm generators are required for very large cross-compound machines the application of the supercharged principle will permit building these larger 1800-rpm generators without requiring larger forgings than are now being used.

C. D. Wilson.[4]

Nuclear-Fueled Power Plants

Comment by W. E. Cooper[5] and W. L. Fleischmann[6]

THE AUTHOR has contributed from his knowledge and background a most valuable paper,[7] showing the complexity of problems entering into the evaluation of materials for nuclear power reactors. To assure a correct choice of materials not only property data as they are obtainable from laboratory tests must be

[1] Chief Engineer of Power Plants, Wisconsin Electric Power Company, Milwaukee, Wis. Mem. ASME.

[2] "Large-Capability Steam-Turbine-Generator Units," by C. D. Wilson, MECHANICAL ENGINEERING, vol. 77, May, 1955, pp. 407–410.

[3] Section Engineer, South Philadelphia Works, Westinghouse Electric Corporation, Lester, Pa. Mem. ASME.

[4] Engineer-in-Charge, Steam Turbine Design, Power Equipment Division, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Mem. ASME.

[5] Engineer, Knolls Atomic Power Laboratory, Schenectady, N. Y. Mem. ASME. The Knolls Atomic Power Laboratory is operated for the United States Atomic Energy Commission by the General Electric Company, under Contract No. W-31-109 Eng-52.

[6] Welding Engineer, Knolls Atomic Power Laboratory. Mem. ASME.

[7] "Evaluating Basic Materials for Nuclear-Fueled Power Plants," by D. O. Leeser, MECHANICAL ENGINEERING, vol. 77, June, 1955, pp. 501–504.

available, but their significance in relation to the service experience with that equipment has to be taken into account.

In the reactor field, in place of experience, engineers have to substitute detailed analytical studies of how certain operating conditions may affect the loading of the various parts of the reactor. Such studies have shown the importance of thermally induced stresses, whether they result from high thermal fluxes in the core, from temperature swings, which are particularly important in liquid metal-cooled reactors, or from gamma-ray heating. The Boiler and Pressure Vessel Code is rather vague on how to assess thermal stress in regard to Code allowed working stresses.

The materials engineer and stress analyst must work out a new set of rules based on analysis and test. For example, it has been established that higher-strength materials than now allowed by the Code are desirable for the future development of reactors and that detail design studies are necessary to arrive at sound engineering structures. It also should be recognized that increased importance must be given to the quality of materials from which the nuclear power plant is built. Hence nondestructive test methods take on added significance in this field.

Comment by R. C. Dalzell[8]

The writer believes it might be well to soften two of the implications relating to coolant and corrosion.

The author seems to imply that deposition of corrosion and fission products has a peculiar effect on the efficiency of heat sources and heat-transfer surfaces. The writer's feeling is that the actual interference offered is exactly the same whether the materials are radioactive or nonradioactive. The factor that is possibly different in a reactor heat source is that the neutron bombardment might affect the tendency to precipitate materials from solution, thus impairing heat transfer more than otherwise would be expected. On the other hand, a heat-transfer surface outside of the reactor will be expected to behave just like any other heat-transfer surface, unless gamma radiation likewise affects the chemistry of precipitation.

One of the important problems related to this is the transfer of substantial amounts of metal from one section of the system to another, leading to constriction or actual plugging of fluid paths. It seems to be encountered principally in nonaqueous systems. This is not necessarily related to the nuclear process; it is not a new problem in the power industry. It was recognized and solved many years ago in the case of mercury boilers, for instance.

Finally, attention is directed to the author's careful choice of words in his statement that reactor coolant systems "must be designed for minimum leakage," and that "care must be observed to reduce the leakage from pipes and turbines." Quite properly, he does not insist upon elimination of all leaks. Leakage must be controlled and the escaping water, steam, or other coolant handled safely.

[8] Division of Reactor Development, U. S. Atomic Energy Commission, Washington, D. C. Mem. ASME.

Comment by H. A. Saller[9] and F. A. Rough[9]

The author has done a good job of indicating many of the materials problems and requirements that must be evaluated in the construction of a power reactor. However, in treating the subject in a general way, it may not be apparent to the people who are new in the field that many of these problems are very complex. Much research has been done to develop solutions to a number of the problems and, although progress has been made, economic nuclear power may well depend upon even better solutions yet to be developed. The continuing improvement of materials and processes for reactor construction is a definite challenge to those in the nuclear-power industry.

Author's Closure

The author wishes to acknowledge the comments by Messrs. Cooper, Fleischmann, Dalzell, Saller, and Rough. Each has quite properly pointed out that the subject matter has been treated in a general way, and hence many conditions must be evaluated according to the specific requirements of the particular reactor. Reactor engineers are in continuous search for additional test data, criticism concerning the basic-design procedures proposed, allowable stresses under various loading conditions, and methods of calculation, together with recommended alternates where appropriate.

Much work has been done in collecting data and adapting these data. Codes are being reviewed in an effort to develop rational structural design bases for reactor pressure vessels. Research work is being guided toward the solution of engineering problems as well as the quest for a basic understanding of these problems. Nuclear engineering is still in its infancy and as it develops, the materials-evaluation program can be expected to be prepared to meet the changing conditions.

D. O. Leeser.[10]

[9] Battelle Memorial Institute, Columbus, Ohio.

Ultrasonic Attenuation

Comment by H. A. Elion[11] and H. E. Van Valkenburg[12]

The author is to be complimented for bringing to the attention of metallurgists and engineers the multifold potentialities of ultrasonic attenuation studies in metals.[13] The program at Brown University should contribute toward an understanding of attenuation mechanisms and to further advancement of practical applications. These techniques are analogous to those which have been utilized effectively by physicists to obtain valuable data on the mechanical properties of fluids and plastics.

The development of equipment operable at very high frequencies, and the use of the exponential comparator are particularly commendable.

It is of historical interest that Dr. Floyd A. Firestone, during his early work on ultrasonic pulsed wave-trains in solids, anticipated many potential metallurgical applications. His investigations culminated in the invention of the ultrasonic reflectoscope in 1940. Several practical laboratory units were soon built and in 1945 commercial instruments for production materials inspection were released. By 1948 Dr. Firestone had developed many valuable techniques such as those discussed in his Mehl Lecture to the ASTM describing grain-size determination, detection of residual stresses, measurement of aeolotropy, and study of structure by the use of scattered energy. Use of the attenuation principle for the detection of unrefined grain structure in forgings became widespread, particularly for quality control of jet-engine bucket wheels. Known as the "loss of back-reflection" method, it was reported in detail in *Metal Progress* (1950). J. C. Hartley and E. K. Mull reported in

[10] Nuclear Power Development Department, The Detroit Edison Company, Detroit, Mich.

[11] Physicist, Engineering Department, Sperry Products, Inc., Danbury, Conn.

[12] Research Engineering Supervisor, Engineering Department, Sperry Products, Inc.

[13] "Ultrasonic Attenuation Measurements for Study of the Engineering Properties of Materials," by Rohn Truell, Mechanical Engineering, vol. 77, July, 1955, pp. 585–587.

Iron Age (1949) on their study of ultrasonic transmission as related to heat-treatment and the detection of overheated material.

It is felt that the following suggestions may further clarify certain important aspects of ultrasonic techniques as related to practical quality-control problems.

1 Commercial materials-inspection equipment, using pulsed wave-trains, while primarily intended for detection of harmful discontinuities, can be utilized effectively for velocity determination, attenuation studies, and scattering investigations in the frequency range of 200 kc to 25 mc.

2 For many so-called engineering materials, it may not be necessary, and may be impossible, to use very high frequencies (i.e., above 25 mc). In the two reflectoscope applications referred to, useful results were obtained below 10 mc. The data for Fig. 6 of this paper were obtained in the 5-mc to 15-mc range.

3 Certain engineering properties such as elastic moduli can be measured directly and quantitatively by ultrasonic techniques since the laws of mechanics define the relationships. As noted in this paper, this is accomplished by a simultaneous measurement of ultrasonic velocity and material density. Other properties such as hardness, tensile, and impact strength are complex functions of structure yet to be defined. Ultrasonic attenuation is in turn complexly related to structure. This dual problem can be a barrier in attempts to correlate such properties directly with ultrasonic phenomena except for cases where specimens of accurately controlled metallurgy exist.

4 While the work referenced, and the present program at Brown do constitute a substantial proportion of the basic attenuation studies to date, certain other sources might well be included. It is suggested that those interested in this general field refer to the monumental review by Dr. L. Bergmann, "Der Ultraschall," having a lengthy bibliography including many items relating to materials inspection, propagation in solids, instrumentation, techniques, and so forth.

With reference to attenuation studies, the contributions of D. L. Arenberg, W. M. A. Anderson, J. K. Galt, F. A. Firestone, H. B. Huntington, P. Bastien, N. Grossman, L. Gurevich, and L. Gold might be mentioned.

5 An ultrasonic investigation of case-depth measurement now in progress by the writers' company indicates that the use of scattered energy from structure discontinuities may be equally as useful as attenuation techniques. The former method is applicable to massive specimens, and to those having irregular geometry, as well as to precision-machined samples having parallel faces as required for the multiple-reflection attenuation technique.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Nuclear-Engineering Glossary

A Glossary of Terms in Nuclear Science and Technology. R. C. Gibbs, chairman, National Research Council Glossary Conference, NRC; 21 societies and organizations engaged in the nuclear field. The American Society of Mechanical Engineers, New York, N. Y., 1955. Paper, $5^1/_2 \times 8^1/_2$ in., figs., c and 189 pp., $5.

Reviewed by Thomas E. Murray[1]

This volume is a compilation of definitions of specialized terms which have arisen with the development of nuclear science and engineering, or which are especially useful in those fields. It has been prepared under the sponsorship of the National Research Council Conference on Glossary of Terms in Nuclear Science and Engineering in co-operation with 17 scientific and technical societies, and with several Government agencies and offices including the Atomic Energy Commission. The need for such a glossary has been steadily growing as increasing numbers of engineers, scientists, and executives have become associated with the rapidly expanding field of the nuclear sciences. Careful planning, extensive effort, and widespread participation in its preparation have combined to make this glossary one that should effectively fill that need.

The present volume is the outgrowth of several years' work. In 1948 the National Research Council, acting on the suggestion of several scientific and technical societies, called a Conference with the objective of co-ordinating the various efforts on glossaries then in progress. The American Society of Mechanical Engineers, in particular, had already made considerable progress along these lines. The plan approved by the Conference was to "co-ordinate activities in specialized fields with the comprehensive plan for a glossary already formulated and initiated by the ASME committees and to arrange for critical review and revisions by critics."

The Glossary was prepared first in separate sections covering terms in the following subjects: Physics, Reactor Theory, Reactor Engineering, Chemistry, Chemical Engineering, Biophysics, Radiobiology, Instrumentation, Isotopes Separation, and Metallurgy. Preliminary editions of these sections were issued separately and then gathered in one volume in 1953. The breadth in scope of the project is indicated by the subjects covered.

The present Glossary retains the same breadth as the earlier volume. Moreover, it has been improved in an important way by the consolidation and co-ordination of the separate sections into a unified whole. This makes for greater ease of use and eliminates some duplication of terms necessarily characteristic of the earlier publication.

The Glossary is useful in several respects. It contributes to clarification of terms and standardization of usage—a much-needed and difficult task in a field where new concepts and discoveries are continuously adding to the terminology. It is so detailed as to be a minor compendium of nuclear knowl-

[1] Commissioner, United States Atomic Energy Commission, Washington, D. C. Fellow ASME.

edge. As such it will be of use to scientists and engineers who are in need of definitions of nuclear terms, but who have neither a background in nuclear sciences nor the opportunity to explore the subject fully.

The Conference has proposed that the Glossary, provided it finds general acceptance, be submitted for approval as the American Standard. The National Research Council, The American Society of Mechanical Engineers, and all whose foresight and effort have combined to make this volume available are to be commended for their timely and worthwhile contribution to the advancement of nuclear science and technology.

Nuclear-Reactor Engineering

Principles of Nuclear-Reactor Engineering. By Samuel Glasstone, with the assistance of several ORNL staff members. D. Van Nostrand Company, Inc., New York, N. Y., 1955. Cloth, $5^3/_4 \times 9$ in., figs., tables, references, appendix, index, ix and 861 pp., $7.95.

Reviewed by S. A. Tucker[2]

The author has spent nearly two years in assembling the basic principles on which nuclear-reactor engineering depends. Much of the content of this book has only recently been declassified.

Published by authority of the U. S. Atomic Energy Commission, this book is aimed at the practicing engineer who wishes to know something of the impact of nuclear reactors on his professional activities. It also is so presented as to become a basic text for the coming generation of nuclear engineers.

It is difficult for this reviewer to restrain his enthusiasm about having in hand in one volume so much information about reactors, fuel, moderators, coolants, and design. This compendium obviates library search through countless individual papers and reports, many of which are still classified.

The first four chapters deal with nuclear reactions, in steady state and disturbed. Two more cover instrumentation and control. Fuel, materials of construction, radiation protection, and shielding follow. The final chapters are concerned with reactor systems and variables, including descriptions of several existing reactors.

Assuming a reasonable familiarity with the integral calculus and some background in nuclear physics, any engineer can now familiarize himself with the process by which fission produces useful heat and the mechanisms by which heat can be transferred to a working fluid for power.

While Dr. Glasstone and his several associates of the Oak Ridge staff have been careful to consider most of the necessary mathematics, physics, and chemistry to describe the definitive reactions and processes, the chapters can be read for background by a layman of little nuclear experience. Many reactions are illustrated with numerical problems worked through in some detail. For the more serious student, sufficient of the theory and mathematics is presented for a clear understanding of these new phenomena. Problems complete each chapter. The work is also thoroughly cross-referenced to other published material.

In the development of a brand new technology of reactor engineering, the author has deftly drawn together and organized the first comprehensive introduction to the wide areas included in the field of reactor engineering.

[2] ASME representative on AEC Advisory Committee on Industrial Information. Mem. ASME.

Books Received in Library...

Analysis of Feedback Control Systems. By Robert A. Bruns and Robert M. Saunders. 1955, McGraw-Hill Book Company, Inc., New York, N.Y. 383 p., $9^1/_4 \times 6^1/_4$ in. bound. $7.50. The two major parts of this text deal, respectively, with servomechanism and regulator components and with feedback-system theory. Basic physical laws are given for electrical, magnetic, mechanical, pneumatic, and hydraulic elements. These, in turn, are used as a foundation for the system analysis. The frequency-response approach is used throughout.

Brazing Manual. Prepared by American Welding Society, Committee on Brazing and Soldering. 1955, Reinhold Publishing Corporation, New York, N. Y. 193 p., $9^1/_4 \times 6^1/_4$, bound. $4.75. Practical information on all brazing processes used in the automotive, aircraft, electronics, refrigeration, and other mass-production metal industries. It describes in detail principles, equipment, and procedures from precleaning and surface preparation to postbraze cleaning and inspection. Techniques are given for brazing all the important metals.

Calcul Numérique des Plaques et des Parois Minces. By Pierre Dubas (Institute of Applied Statics, E. T. H. Zürich, publication no. 27). 1955, Verlag Leeman, Zürich, Switzerland. 175 p., $8^3/_4 \times 6$ in., paper. 15 Sw. fr. The detailed mathematical analysis of plates and thin walls as described here is based on original developments by Professor Stüssi in the field of applied statics. The general theory is discussed, the manipulation of the pertinent differential equations is demonstrated, and specific examples are worked out numerically.

Library Services

Engineering Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Centrifugal and Other Rotodynamic Pumps. By Herbert Addison. Second edition, 1955, Chapman and Hall Ltd., London, England. 530 p., $8^3/_4 \times 5^3/_4$ in., bound. 50s. The entire range of centrifugal, screw, and propeller pumps is covered in four sections dealing with principles, design and construction, performance, and installation. In the revision, minor changes have been made in accordance with advances in practice, and the bibliography has been brought up to date. Forty-eight worked examples of pump and pumping-plant problems are appended.

Flammspritzen, von Stahl, Metallen und Kunststoffen. By J. C. Fritz. 1955, Verlag W. Girardet, Essen, Germany. 152 p., $8^1/_4 \times 6$ in., bound. 19.80 DM. This small book constitutes a practical manual on the flame spraying of steel, various other metals, and plastics. It presents the fundamental properties of metals, alloys, and plastics; describes in detail a considerable range of equipment and operational procedures; and discusses the installation of a spraying shop. An extensive bibliography is included, mainly German references.

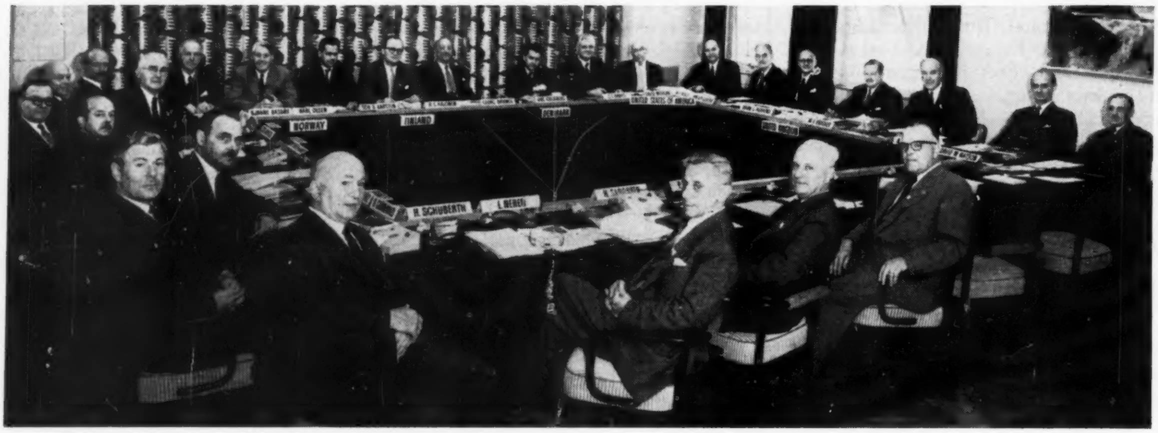
Fundamentals of Friction and Lubrication in Engineering. American Society of Lubrication Engineers, Chicago, Ill., 1954. 196 p., $8^1/_2 \times 5^1/_2$ in., paper. $3.50. The 12 papers presented in this first ASLE National Symposium cover many aspects from historical and general surveys of the hydrodynamics of lubrication to specialized treatments of various bearing types, the constitution of lubricants, friction problems, and wear.

Gleichgewicht und Stabilität. By Klaus Zweiling. 1953, Verlag Technik, Berlin, Germany. 188 p., $9^1/_2 \times 6^3/_4$ in., bound. 30 DM. A critical investigation of three important problems of the theory of elasticity dealing with equilibrium and stability: The convergence of the Engesser-Vianello method; the principle of virtual displacement and variation principles of the theory of elasticity; stability of multiple-span elastically supported members.

Vorrichtungen Für Die Zerspannung. By Ch. L. Bolotin and F. P. Kostromin. VEB Verlag Technik, Berlin, Germany, third edition, 1953. 522 p., $9^1/_2 \times 6^3/_4$ in., bound. 22 DM. The design of jigs and fixtures is dealt with in this German translation of a 1951 Russian textbook. A wide range of types for metal cutting and working equipment is described in detail, with examples of practical applications. Representative standards are illustrated, and a bibliography of Russian works on the subject is appended.

ASME NEWS

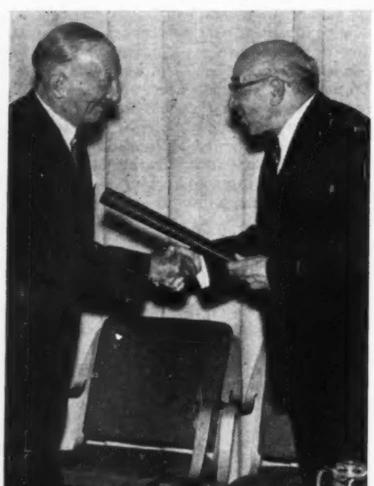
With Notes on the Engineering Profession



EUSEC Conference held in Copenhagen, Denmark, Sept. 5–9, 1955, is shown during a session. Seated at the far side of the table is the U. S. A. delegation including C. E. Davies, secretary, ASME; David W. R. Morgan, President, ASME; W. H. Wisely, executive secretary, ASCE; and W. R. Glidden, President, ASCE.

ASME Stages 75th Anniversary Celebration at EUSEC Meeting in Denmark

Engineering subjects discussed at EUSEC Meeting. American Embassy in Copenhagen scene of an ASME Jubilee event



Dr. Morgan, *right,* presenting certificate of Honorary Membership in ASME to Georg F. C. Dithmer, President, Danish Institution of Civil Engineers and chairman of Engineering Societies of Western Europe and the United States (EUSEC) at reception in American Embassy in Copenhagen, Denmark, Sept. 6, 1955

•EUSEC Meeting

Twenty-six representatives of fifteen engineering societies in twelve nations assembled in Copenhagen, Denmark, September 5 to 9, 1955, to participate in the Fifth Conference of Engineering Societies of Western Europe and the United States of America (EUSEC).

The Danish Institution of Civil Engineers acted as host, the meetings being held in the attractive new buildings of the Institution with the President, Georg F. C. Dithmer, serving as president of EUSEC and Secretary Ove Guldberg as EUSEC secretary.

U. S. A. was represented by President W. R. Glidden and Executive Secretary W. H. Wisely of the American Society of Civil Engineers and President David W. R. Morgan and Secretary C. E. Davies of ASME.

Other societies represented were one each from Austria, Belgium, France, Germany, Holland, Norway, Switzerland, Sweden; two from Finland; and from the United Kingdom, the three Institutions of Civil, Mechanical, and Electrical Engineers.

Subjects Discussed

The subjects discussed at Copenhagen included (*a*) better means of co-operation between EUSEC and the Pan-American Federation of Engineering Societies (UPADI); (*b*) a clarification of engineering organizations within Europe; (*c*) better service for student members; (*d*) uniform definitions of the terms "professional engineer" and "engineering technician"; (*e*) exchange of visiting lecturers; (*f*) formal co-operative agreements between professional societies; (*g*) codes of practice for consulting engineers; (*h*) the responsibility of engineers in conserving natural resources; and (*i*) nuclear-energy discussion forums. These subjects are largely related to the internal operating problems of engineering

societies and their discussion resulted in a valuable interchange of experience. Three problems of more general interest were education, engineering manpower, and abstracting.

Engineering Education

Under EUSEC auspices two conferences on engineering education and training have been held. A third is projected for Paris in September, 1956. This will be a small meeting of Society representatives to review reports from fact-finding parties. There was some feeling that larger meetings to discuss educational questions would have value especially in Europe but EUSEC decided to consider further meeting plans after the Paris meeting was held and its value appraised.

Engineering-Manpower Shortage

The critical engineering-manpower shortage in the various countries was the subject of extended discussion and the decision was reached to establish a working party, one from each country, the secretariat being held by U. S. A. to interchange frequent reports of the activities being taken to reduce the shortage and improve the utilization of engineers. In this connection EUSEC was successful in securing the declassification of a report on supply and demand of engineers prepared by a committee of the Organization for European Economic Co-Operation.

Engineering Abstracting Services

The EUSEC meeting decided to use the Bibliography of Engineering Abstracting Services prepared by the U. S. A. Special Libraries Association as the basis for a shorter list of abstracting services freely available and containing a significant number of abstracts per annum.

The results of the conference are embodied in resolutions to be acted upon by the boards of the participating societies.

Leaders of foremost Engineering Societies gathered in Copenhagen, Denmark, Sept. 5–9, 1955, to attend EUSEC Conference. Shown, *left to right,* seated in first row are: William Roy Glidden, President, American Society of Civil Engineers; Georg F. C. Dithmer, President, Danish Institution of Civil Engineers and Chairman of Engineering Societies of Western Europe and the United States (EUSEC); David W. R. Morgan, President, The American Society of Mechanical Engineers; David M. Watson, President, The Institution of Civil Engineers, Great Britain. Second row, seated: H. Schuberth, President, German Society of Engineers; Dr. L. Neher, President, Dutch Institute of Engineers; M. Berger-Hainut, President, Royal Society of Belgian Engineers; J. Eccles, President, The Institution of Electrical Engineers, Great Britain. Standing: Georges Ville, Secretary, French Society of Civil Engineers; P. E. Soutter, Secretary, Swiss Society of Engineers and Architects; Brian G. Robbins, Secretary, The Institution of Mechanical Engineers, Great Britain; Otto Weywoda, Secretary, Austrian Society of Engineers and Architects; Bo Jondal, President, Swedish Engineering Society; R. S. Halonen, Secretary, Joint Council of Engineering Societies in Finland; and Karl Olsen, President, Norwegian Engineering Society.

The general highly cordial and co-operative atmosphere of the meeting was induced by the friendly surroundings and the informal program provided by the Danish hosts for the official representatives and their wives. The planned proceedings moved smoothly under the guiding hand of President Dithmer. The serious painstaking consideration of the agenda by the leaders of the profession was a fine example of how men of good will may work together. The spirit of co-operation at the meeting made the gathering worth while even though tangible results are not immediate.

Robert Coe, American Ambassador to Denmark, is shown addressing the guests who attended a celebration held at the American Embassy in Copenhagen marking the 75th Anniversary of The American Society of Mechanical Engineers. Seated, *left to right,* are: C. E. Davies, secretary, ASME; W. H. Wisely, executive secretary, ASCE; Col. Crosby Field, Fellow ASME; W. R. Glidden, president, ASCE; Georg F. C. Dithmer, who at this event was made Hon. Mem. ASME; and ASME President Morgan.

•ASME Celebration in Denmark

The EUSEC meeting in Copenhagen gave ASME an opportunity to extend the 75th year celebration to Europe. Accordingly on Tuesday afternoon, September 6, following the day's sessions, the EUSEC delegates and their wives were the guests of the ASME at the American Embassy.

Ambassador Coe Greets Guests

With President Morgan in the chair, Ambassador Robert Coe welcomed the guests, congratulated ASME on its 75th year, and paid tribute to the part played by engineers in dealing with and solving knotty international problems and in sharing with engineers of lesser-developed countries the knowledge and skill necessary to develop their countries' resources and raise the living standard of the people in these areas.

President Morgan Restates ASME Policy

President Morgan then restated the ASME time-honored policy of international engineer-

Georg F. C. Dithmer, Hon. Mem. ASME and president, Danish Institution of Civil Engineers, chats with H. Schuberth, president, German Society of Engineers, and Georges Ville, secretary, French Society of Civil Engineers

ASME President Morgan chats with P. E. Soutter, secretary, Swiss Society of Engineers and Architects, and E. Hianne, secretary, Royal Society of Belgian Engineers, during an ASME 75th Anniversary event in Copenhagen

ing co-operation and recited briefly the activities in support of the policy. He announced the decision of the ASME Council as a feature of the celebration of the 75th Anniversary, to honor the groups with which ASME has been associated internationally. He then presented 75th Anniversary Medals to the societies' representatives.

G. F. C. Dithmer Made Honorary Member

President Morgan then conferred ASME Honorary Membership upon Georg Frederik Charles Dithmer, chairman of EUSEC, president of the Danish Institution of Civil Engineers, eminent mechanical engineer, shipbuilder, and manager, thereby honoring an eminent European engineer and extending the greetings and appreciation of ASME to the Conference of Engineering Societies of Western Europe and the United States of America.

After the first public showing of the ASME 75th Anniversary film "To Enrich Mankind," which was enthusiastically received, the party adjourned for cocktails.

Through the courtesy of the United States Information Service, each society representative made a short tape-recorded message of congratulations to the Society on its Anniversary. These messages, in the language of the speaker, were sent to the radio chains of the respective countries.

Special Exposition Insert

A REPORT on the Machine Tool Show, Production Engineering Show, and Machinery Show, held in Chicago, Ill., Sept. 6–17, 1955, and a preview of ASME's coming Chicago Exposition of Power and Mechanical Engineering appears in a special insert in the Advertising Section of this issue of MECHANICAL ENGINEERING.

The ASME Exposition, to be held at the Chicago Coliseum, November 14–18, will run concurrently with the ASME Diamond Jubilee Annual Meeting.

ASME Establishes Lubrication Division

IN September the Council of The American Society of Mechanical Engineers approved the application of "Lubrication Activity" for Division status, and a new Professional Division—the Lubrication—became of age. It starts to function as a division during the Diamond Jubilee Annual Meeting in Chicago, Ill., November 13–18. All interested in lubrication are invited to attend its meetings. The Division begins its new life with an active group of over 200 engineers. (See ASME Master-File Information box in this issue, page 1038, to facilitate registration in the Lubrication Division.)

Co-Ordinating Committee

In 1949 the ASME Petroleum Division, realizing that the work of its subcommittee on lubrication cut across the activities of all Professional Divisions, set up a Co-Ordinating Committee on Lubrication consisting of representatives from many Professional Divisions as well as engineers especially interested in lubrication. Through the efforts of many interested in lubrication to enlarge the scope of this Committee, a pilot organization, called the "Lubrication Activity," was established under the direct guidance of the Professional Divisions Committee. A. C. Stutson of Socony Mobil Oil Company as its chairman, organized the "Activity" with Committees to cover research, machine design, builders, operators, and co-ordination.

The increasing interest of members in the work of the Lubrication Activity led the Professional Division Committee to recommend the formation of the new Lubrication Division.

It is organized with two administrative committees; Executive, under the chairmanship of Dr. D. F. Wilcock of General Electric Company, who was vice-chairman of the Lubrication Activity, and Program. Five technical committees, Research, Lubricants, Design, Builders, Operators, and Co-Ordination have been formed.

Objectives of Division

The objectives of the new Division are as follows:

To promote the art and science of mechanical engineering in lubrication;

To foster research and development;

To disseminate information;

To summarize and publish reliable data pertaining to lubrication; and

To encourage the interchange of ideas among engineers and technologists.

Geneva Nuclear "Package" of Secret Reactor Data Includes Handbooks and Drawings

ASME credited with assistance in preparation of research-reactor and chemical-processing volumes

In preparation for wholesale declassification of hitherto secret data and drawings for the International Atoms-for-Peace Conference, held in Geneva, Switzerland, August 8–20, the United States Atomic Energy Commission asked The American Society of Mechanical Engineers to assist in compiling and editing two volumes of the seven which made up the information package to be supplied each national delegation. With the exception of the first booklet which introduces in four languages the other six books, the package is now available in this country.

Research and Engineering Methods and Data

The 3291 pages of the six books include a vast amount of specific data of reactors and associated equipment not possible of declassification under the Atomic Energy Act of 1946, but releasable under the 1954 statute. Three volumes are the previously secret "Reactor Handbook" under the subtitles of "Physics," "Engineering," and "Materials." A supplementary volume of charts (16 × 10 in.) declassifies "Neutron Cross Sections" for most useful reactor materials. Two new books, which credit ASME co-operation, detail "Research Reactors" and "Chemical Processing and Equipment." A feature of these volumes is the nearly complete set of detail drawings and illustrations, piping and wiring diagrams, instrumentation, and operating procedures for the basic reactor types.

Ever since the formation of ASME Nuclear Energy Application Committee in 1947, one of the objectives of the Society has been the assembly and preparation of basic technological information which will be needed by the coming industry concerned with nuclear power. With the publication of these volumes a tremendous stride has been taken in the direction of assembling the fundamental knowledge useful to nuclear engineers of the near future on a completely declassified basis.

Research Reactors

The volume on research reactors is an assembly of six chapters each dealing with a selected reactor. In each case the reactor design is described in detail with accompanying assembly and detail drawings. Auxiliary facilities are noted and described. Fuel elements, moderators, operating mechanisms, and other details of construction are fully described and illustrated. Data on reflectors and shields are included. Start-up, operation, instrumentation, and safety provisions are detailed.

The six reactors described were carefully selected to represent 15 now in use. Type I—homogeneous—enriched fuel, has been known as the "water-boiler" reactor, of which the core is a sphere less than one-foot diameter. Type II—heterogeneous—enriched fuel, has been called the "swimming-pool" reactor because the shielding is furnished by ordinary water. The reactor set up at Geneva and later sold to the Swiss is of this type and fully described. (See October, 1955, issue of MECHANICAL ENGINEERING, Fig. 1, page 893 and page 906.) Type III—heterogeneous—enriched fuel, is the 1952 MTR which furnishes the highest test-flux of any research reactor. Type IV—heterogeneous—enriched fuel is the neutron-test reactor NTR. Type V—heterogeneous—enriched fuel, is the heavy-water moderated CP-5 of Argonne development. Type VI—heterogeneous—natural fuel, is the air-cooled unit at Brookhaven National Laboratory.

(Note: Homogeneous indicates fuel and coolant in solution; heterogeneous denotes solid-fuel and flowing-liquid coolant.)

Reactor Handbooks

The significant item concerning the three volumes of the Reactor Handbook is the fact that so little of the total information in the areas of Physics, Engineering, and Materials has had to be extracted because of secrecy classification. To all intents and purposes the universities and others concerned with assembly of nuclear information now have all basic necessary science and technology. The areas still withheld deal primarily with production figures and fuel metallurgy that are not of primary interest to reactor engineering. This statement applies to fundamentals; a great store of know-how that cannot be put into books remains with those who have invested many man-years in development of reactor engineering.

The volume devoted to materials, as might be expected, concerns many metals, alloys, and nonmetallics not normal to previous construction. Zirconium and its alloys, for example, were hardly known in earlier literature. Likewise, the neutron-absorbing properties of common materials are of interest only in recent years. The materials volume is a selected assembly of such unusual substances and newly interesting characteristics.

Neutron Cross Sections

"Neutron Cross Sections" is a compilation of charted values for many materials of interest to reactor physicists and engineers. It is only recently that comparison of the neutron-behavior tests has been compared with results obtained in other countries and the good agreement of these results forms the beginning of world "best values."

Chemical Processing and Equipment

The material in "Chemical Processing and Equipment" fills a much-needed want for a catalog and description of the hundreds of

Materials-Testing Reactor (MTR) is the result of an evolutionary process aimed at experimental check of the design of future reactors

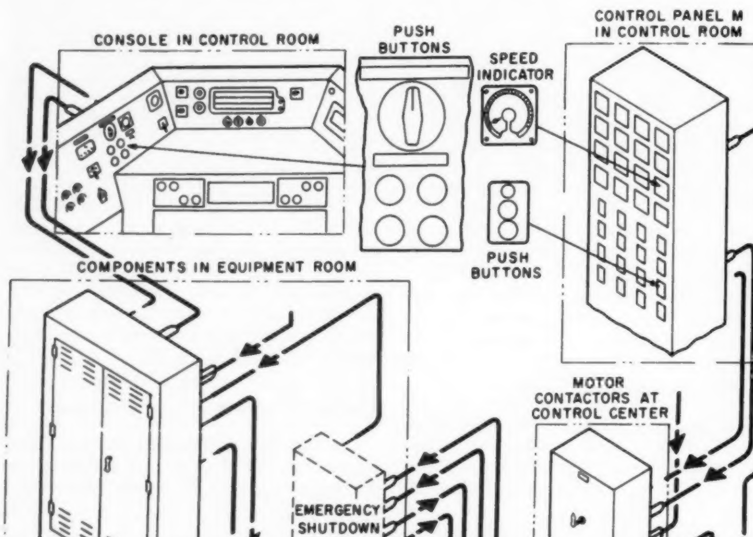
devices such as manipulators, periscopes, remote operators, windows, and the like. Plant procedures as well as laboratory units are discussed.

These books have no connection with the papers presented by individuals of this nation or other nations at the Geneva Conference; the conference papers will eventually be published as "proceedings." (See October, 1955, issue of Mechanical Engineering, page 943.)

Of the six volumes, four were compiled within the framework of the U. S. Atomic Energy Commission. Research Reactors and Chemical Processing and Equipment, together with the introductory pamphlet, were contracted for by AEC from Vitro Corporation of America, which collected the raw material from the several sites, utilizing personnel of the General Precision Equipment Corporation as well as its own.

The editing and processing of more than 600 pages and 500 drawings and illustrations was completed by the Technical Writing Service of the McGraw-Hill Book Company, Inc., with the aid of ASME staff members, within 60 days.

Paper-backed copies may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.; or clothbound, from the McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y.



This diagram of the emergency-rod control system at Brookhaven illustrates how many items of control equipment will be needed for future power reactors

ASME Calendar of Coming Events

Nov. 13–18
ASME Diamond Jubilee Annual Meeting, Hotel Congress, Chicago, Ill.
(Final date for submitting papers was July 1, 1955)

Nov. 14–18
Exposition of Power and Mechanical Engineering, as part of ASME 75th Anniversary Annual Meeting, Coliseum, Chicago, Ill.

March 14–16, 1956
ASME Aviation Division Conference, Hotel Statler, Los Angeles, Calif.
(Final date for submitting papers was Nov. 1, 1955)

March 14–15, 1956
ASME Engineering Management Conference, Hotel Statler, St. Louis, Mo.
(Final date for submitting papers was Nov. 1, 1955)

March 18–21, 1956
ASME Spring Meeting, Multnomah Hotel, Portland, Ore.
(Final date for submitting papers was Nov. 1, 1955)

March 26–27, 1956
ASME Instruments and Regulators Division Conference, Princeton University, Princeton, N. J.
(Final date for submitting papers was Nov. 1, 1955)

April 1–5, 1956
ASME Oil and Gas Power Division Conference, Jung Hotel, New Orleans, La.
(Final date for submitting papers—Dec. 1, 1955)

April 10–11, 1956
ASME Machine Design Division Conference, Bancroft Hotel, Worcester, Mass.
(Final date for submitting papers—Dec. 1, 1955)

April 16–17, 1956
ASME Gas Turbine Power Division Conference, Hotel Statler, Washington, D. C.
(Final date for submitting papers—Dec. 1, 1955)

May 8–11, 1956
ASME Metals Engineering-AWS Conference, Hotel Statler, Buffalo, N. Y.
(Final date for submitting papers—Dec. 31, 1955)

May 23–25, 1956
ASME-EIC Meeting, Mount Royal Hotel, Montreal, Que., Can.
(Final date for submitting papers—Dec. 31, 1955)

June 14–16, 1956
ASME Applied Mechanics Division Conference, University of Illinois, Urbana, Ill.
(Final date for submitting papers—Feb. 1, 1956)

June 17–21, 1956
ASME Semi-Annual Meeting, Hotel Statler, Cleveland, Ohio
(Final date for submitting papers—Feb. 1, 1956)

Sept. 10–12, 1956
ASME Fall Meeting, Denver, Colo.
(Final date for submitting papers—May 1, 1956)

Sept. 17–21, 1956
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Coliseum, New York, N. Y.
(Final date for submitting papers—May 1, 1956)

Sept. 23–26, 1956
ASME Petroleum-Mechanical Engineering Conference, Conrad Hilton Hotel, Dallas, Texas
(Final date for submitting papers—May 1, 1956)

Oct. 8–10, 1956
ASME-ASLE Third Lubrication Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.
(Final date for submitting papers—June 1, 1956)

Nov. 25–30, 1956
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(Final date for submitting papers—July 1, 1956)
(For Meetings of Other Societies, see page 1027)

ASME-Sponsored Papers Announced for Nuclear Congress, December 12–16

EJC co-ordinating meeting of 26 engineering and scientific societies. AIChE to sponsor International Atomic Exposition, Dec. 10–16

Of the more than 300 technical papers describing the latest atomic developments to be presented at the Nuclear Engineering and Science Congress to be held in Cleveland, Ohio, December 12–16, twenty-seven are sponsored by The American Society of Mechanical Engineers.

This first co-operative congress of its kind, sponsored by the nation's leading engineering and scientific societies, of which ASME is one, will present papers from industry, government agencies, and universities. The work of the 26 co-operating societies in the Congress is being co-ordinated by Engineers Joint Council. The headquarters hotel for the Congress will be the Hotel Statler.

International Atomic Exposition

In conjunction with this Congress an International Atomic Exposition, sponsored by the American Institute of Chemical Engineers, will exhibit the most recent developments here and abroad in industrial applications of atomic energy, including a working reactor. The exposition will be held at the Public Auditorium from December 10 through 16; registrants at the Congress will be admitted by badge to the exposition.

Congress Papers

John R. Dunning, Mem. ASME, chairman, EJC General Committee on Nuclear Engineering, in describing the scope of the Cleveland Congress, said, "The Nuclear Congress will be a most comprehensive program of papers and discussions looking toward industrial uses of the atom to benefit all mankind. Many of the nation's most eminent scientists and engineers will participate. Out of the week of meetings should come important guideposts to the nation's peacetime development of nuclear energy."

Dr. Dunning went on to say that declassification of restricted information, in preparation for the Geneva meetings, makes possible open discussion and planning at the Cleveland Congress, looking toward wider-scale peaceful uses of atomic energy. Emphasis will be on industrial possibilities.

ASME-Sponsored Papers

The following is the list of ASME-sponsored papers: (Wherever possible the preprint number precedes the title of the paper.)

1 **Interpretations of the Purpose, Scope, and Operation of the Reactor Safeguard Committee,** by *C. R. McCullough,* AEC Reactor Safeguard Committee

39 **Liquid-Metal Fuel Reactor for Central-Station Power,** by *D. J. Sengstaken,* Long Island Lighting Co., and *Edwin Durham,* The Babcock & Wilcox Co., working at Brookhaven National Laboratory

Steady-State and Transient Heat-Transfer Problems in Water-Cooled Reactors, by *L. S. Mins,* Westinghouse Electric Corp.

46 **Steam Generation in a Reactor,** by *M. W. Carbon, W. D. Gilbert, C. R. McNutt,* and *R. Neidner,* General Electric Co.

Free-Convection Heat-Transfer Rates Inside a Horizontal Pipe, by *J. P. Fraser* and *D. J. Oakley,* General Electric Co.

7 **Essential Differences Among Basic Types of Reactors and Comparison of Significant Safety Considerations Peculiar to Each,** by *Stuart McLain* and *R. O. Brittan,* Argonne National Laboratory

8 **Proposed Structural-Design Basis for Nuclear-Reactor Pressure Vessels,** by *W. E. Cooper,* Knolls Laboratory, General Electric Co.

Safety Aspects of the Fast Breeder Reactor, by *W. J. McCarthy* and *F. C. McMath,* Atomic Power Division Associates, Inc.

Safety Aspects of Water-Cooled and Moderated Reactors, by *R. J. Creegan,* Westinghouse Electric Corp.

11 **Reactor Shielding,** by *E. P. Blizard,* Oak Ridge National Laboratory

Experimental Facilities for Shielding Studies, by *H. E. Hungerford, Jr.*

17a **Radiation-Hazard Control for a Power Reactor,** by *G. H. Whipple,* The University of Rochester

Extracting Heat From Liquid-Metal Fuels, by *D. Mars, R. T. Schoemer,* and *R. Carlson,* The Babcock & Wilcox Co.

49 **Selection of Materials, Design, and Specialized Fabrication Procedures for Sodium and Sodium-Potassium Cooled Heat-Transfer Systems,** by *W. L. Fleischmann* and *R. F. Koenig,* Knolls Laboratory, General Electric Co.

50 **Liquid Bismuth as a Fuel Solvent and Heat-Transport Medium for Nuclear Reactors,** by *O. E. Dwyer, D. H. Gurinsky,* and *J. R. Weeks,* Brookhaven National Laboratory

52 **Specific Heats of Liquid Metals and Liquid Salts,** by *T. B. Douglas,* National Bureau of Standards

24 **Instrumentation Requirements for a Research-Reactor Facility,** by *C. K. Beck,* North Carolina State College

25 **Reactor Controls and Instrumentation,** by *Samuel Untermyer,* General Electric Co.

27 **Hydraulic Systems in Reactor Control,** by *Michael Silverberg,* Ford Instrument Co.

74 **Comparison of Sodium, Lithium, and Lead as Heat-Transfer Media From a Corrosion Standpoint,** by *W. D. Manly,* Oak Ridge National Laboratory

78 **Fuel Elements for Nuclear Reactors,** by *J. B. Anderson,* Combustion Engineering, Inc.

79 **Design and Development of Components for SRE,** by *W. E. Parkins,* North American Aviation, Inc.

81 **Power-Conversion Systems for Dual-Cycle Boiling Reactors,** by *V. A. Elliott* and *T. Trocki,* General Electric Co.

311 **Pyrometallurgical Processing Method for Nuclear Fuels,** by *M. Levenson,* Argonne National Laboratory

356 **Methods of Replacing Fuel in Nuclear Reactors,** by *Stuart McLain, R. C. Goertz,* and *A. H. Barnes*

234 **Analysis of Temperature Transients in a Nuclear-Power System,** by *R. J. Frits,* Knolls Laboratory, General Electric Co.

355 **Problems of Mechanical Analysis in Reactor Technology,** by *G. Horvay,* Knolls Laboratory, General Electric Co.

Gas-Cooled Liquid-Metal Fuel Reactor, by *H. L. Falkenberry, C. J. Raseman, et al.,* Brookhaven National Laboratory

ASME Membership as of Sept. 30, 1955

Honorary Members	73
Fellows	408
Members	14,538
Affiliates	301
Associate Members (33 and over)	3,810
Associate Members (30 to 32)	4,497
Associate Members (to the age of 29)	16,832
Total	40,459

"Principles of Nuclear Reactor Engineering" Presented to L. L. Strauss by Publisher

Lewis L. Strauss, chairman of the Atomic Energy Commission, accepted on behalf of the AEC, a specially bound copy of the "Principles of Nuclear Reactor Engineering" from E. M. Crane, president of D. Van Nostrand Company, the publisher. The book, written by Samuel Glasstone[1] in collaboration with members of the staff of the Oak Ridge National Laboratory, is the most recent in a series of books on atomic energy sponsored by the AEC.

The book is a comprehensive treatment of the technological and engineering principles which form the bases for present-day practice in the design, construction, and operation of nuclear reactors.

Acting upon a recommendation by the American Society for Engineering Education's Committee on Atomic Energy Education, the Commission engaged Dr. Glasstone, a scientist, educator, and textbook writer, to prepare this source book for reactor-engineering education, based upon the experience of the Commission's laboratories and the material in their files.

Upon completion of the manuscript, bids were solicited from commercial publishing houses, and on the basis of low cost to the buyer, adequate appearance and presentation, and early publication date, D. Van Nostrand Company, Inc., was selected as publisher.

Previous books published under similar programs include Glasstone's "Sourcebook on Atomic Energy" (1950) and Glasstone & Edlund's "Elements of Nuclear Reactor Theory" (1953). Now in its eighth printing, the source book has been translated into six foreign languages (Japanese, German, Spanish, Italian, Serbo-Croatian, and Russian), and over 40,000 copies of the American edition are in print. The theory book is already in its third printing, and several foreign translations are contemplated.

Advance copies of the new book were featured in a display of technical books in the U. S. Library Exhibit at the Geneva Conference on Peaceful Uses of Atomic Energy in August, and aroused considerable interest among the delegations from the many countries represented at the Conference.

[1] See page 1015 of this issue.

People . . .

Honors and Awards. Seven men have been designated for elevation to the highest rank of membership in The American Society of Mechanical Engineers.

Named to honorary membership are the following: Joseph Bradley Armitage, vice-president in charge of engineering, Kearny & Trecker Corporation, Milwaukee, Wis.; James H. Doolittle, vice-president and member of the executive committee, Shell Oil Company, New York, N. Y.; Samuel Broadus Earle, dean of the School of Engineering and director of the Engineering Experiment Station, Clemson College, Clemson, S. C.; Simes Thurston Hoyt, consulting engineer, Castle & Cooke, Ltd., Honolulu, T. H.; Carl George Arthur Rosen, consulting engineer, Caterpillar Tractor Company, Peoria, Ill.; Philip Sporn, president of American Gas & Electric Company, New York, N. Y.; Clyde Elmer Williams, president of Battelle Memorial Institute, Columbus, Ohio.

The new honorary members will be installed at ASME's Diamond Jubilee Annual Meeting in Chicago, Ill., November 13–18.

Honorary membership, conferred for "acknowledged eminence in the engineering field," has been awarded to only 177 persons since ASME's founding in 1880. Among the group are Dwight D. Eisenhower, Ralph E. Flanders, Herbert C. Hoover, Andrew Carnegie, Thomas A. Edison, and George Westinghouse.

Ralph E. Flanders, past-president and Hon. Mem. ASME, U. S. Senator from Vermont, was one of five men honored by the Standards Engineers Society at its Fourth Annual Convention at Hartford, Conn., September 29–October 1. Senator Flanders was honored "in recognition of his outstanding contributions in government and industry." These included development of standard screw threads, making possible greater interchangeability, and encouragement of unified screw threads by the United States, the United Kingdom, and Canada. Senator Flanders was awarded an honorary fellowship in the Society.

Thomas E. Murray, Fellow ASME, Commissioner of the U. S. Atomic Energy Commission, and Philip Sporn, Hon. Mem. ASME, president, American Gas and Electric Company, were among the 17 distinguished leaders to be honored by the Polytechnic Institute of Brooklyn at the concluding celebration of its centennial anniversary. The honorary DE degree was conferred on Messrs. Murray and Sporn at the Centennial Convocation, October 8, held at the Brooklyn Academy of Music.

Charles Erwin Wilson, Secretary of Defense, has been selected to receive the 1955 Washington Award for his "significant leadership in engineering and management and for his altruistic devotion to national defense." This award, which was announced by the Washington Award Commission, is sponsored by the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and is administered by the Western Society of Engineers of Chicago.

Claude E. Shannon, mathematician, inventor, and a member of the technical staff of the Bell Telephone Laboratories, Murray Hill, N. J., was the recipient of the Stuart Ballantine Medal of The Franklin Institute of the State of Pennsylvania. The award was presented at the Institute's Annual Medal Day ceremonies, October 19. Rene A. Higonnet and Louis M. Moyroud, both of Cambridge, Mass., were awarded John Price Wetherill Medals of the Institute "for their conception and development of the Photon type composing machine." Jacques Yves Pierre Sejournet, managing director of Comptoir Industriel d'Etirage & Profilage de Metaux, Persan, France, also was awarded a John Price Wetherill Medal, for his invention of the Ugine-Sejournet Extrusion Process for metals. Richard Y. Case, assistant manager and chief engineer, power-transmission department, United States Rubber Company, was awarded the Edward Longstreth Medal for his invention of the timing belt which is now standard equipment on a great variety of industrial machinery and in such applications as sonar equipment, motors, business machines, sewing machines, gasoline pumps, and power tools.

ASME President D. W. R. Morgan, *left,* presents the Spirit of St. Louis Medal to Ralph S. Damon, *center,* Mem. ASME and president of Trans World Airlines, Inc., New York, N. Y. for "meritorious service in the field of aeronautics" at a dinner held in St. Louis, Mo., September 29. John B. Nichols, *right,* Assoc. Mem. ASME and chief research engineer at Hiller Helicopters, Palo Alto, Calif., received the Spirit of St. Louis Junior Award.

Max Kronenberg, Mem. ASME, consulting engineer, Cincinnati, Ohio, Paul Maker, senior research engineer, and Edward Dix, Mem. ASME, project and design engineer, with Bryant Chucking Grinder Company, Springfield, Vt., shared the $3000 first award in the recent $12,000 Machine Tool Design Award Program sponsored by The James F. Lincoln Arc Welding Foundation of Cleveland, Ohio. The award was made for a paper they wrote describing development work on vibration and rigidity undertaken in designing a new internal-grinding machine with welded-steel construction.

Harry F. Olson of the Radio Corporation of America, received the Samuel L. Warner Memorial Award for 1955 from the Society of Motion Picture and Television Engineers. A gold medal and citation were presented to Dr. Olson on October 4, during the Society's 78th semiannual convention at the Lake Placid Club, Essex County, N. Y. On the same occasion Elmer W. Engstrom, executive vice-president, research and engineering and a director, Radio Corporation of America, received the Progress Award.

Edward O. Ericson, president of The Ericson Manufacturing Company, Cleveland, Ohio, has been elected by the Polytechnic Institute of Brooklyn to honorary membership in the Pi Tau Sigma National Honorary Mechanical Engineering Fraternity.

Scholarship. William J. Conroy, a top-ranking mechanical-engineering student, has been awarded the Carbide & Carbon Chemicals Company Scholarship at Illinois Institute of Technology for the 1955–1956 academic year.

Research. Willard F. Rockwell, Fellow ASME, chairman of the board of Rockwell Manufacturing Company and Rockwell Spring and Axle Company, will assist in preparing a study on "Business Executives in the Federal Government"—a project sponsored by the Harvard Business School Club of Washington, D. C.

Campus News. Charles T. Oergel, Mem. ASME, analytical engineer for General Electric Company, has been appointed head of the mechanical-engineering department of the

New ASME Officers Elected by Letter Ballot

As reported by the tellers of election, 1956 officers, C. B. Peck, H. R. Kessler, and G. J. Nicastro, letter ballots received from members of The American Society of Mechanical Engineers were counted on Sept. 27, 1955. The total number of ballots cast was 11,609; of these 219 were thrown out as defective.

	Votes for	Votes against
For President		
Joseph Warren Barker	11,368	22
For Regional Vice-Presidents—serve two years		
Charles Edwin Crede	11,371	19
Frank William Miller	11,379	11
Albert Carl Pasini	11,368	22
Bryan Towne McMinn	11,365	25
For Directors—serve four years		
(T) Glenn Barton Warren	11,364	26
(C) Louis F. Polk	11,369	21
(A) Joseph Pope	11,368	22
For Directors—serve two years		
(C) Elmer Otto Bergman	11,365	25
For Director—serve one year		
(T) J. F. Downie Smith	11,358	32

The new officers will be introduced and installed in office during the Diamond Jubilee Annual Meeting of the Society to be held at the Congress Hotel, Chicago, Ill., Nov. 13–18, 1955.

Biographical sketches of the newly elected officers were published in the August issue of Mechanical Engineering, pages 741 to 746.

J. K. Wood, vice-president, chief engineer, General Spring Corporation, was a guest at a luncheon held at The Engineers' Club, New York, N. Y., on the occasion of his promotion to Fellow ASME. Shown, *left to right*, are: H. R. Kessler, Fellow ASME, manager, Republic Flow Meters; Mr. Wood receiving a certificate from W. H. Byrne, vice-president, ASME Region II, president, Byrne Associates, Inc.; and H. A. Johnson, chief mechanical engineer, Gibbs & Hill, Inc. Mr. Wood also was presented with a book of greetings from many of his friends and associates from the United States and abroad. In 1923 ASME formed the Special Research Committee on Mechanical Springs, proposed by Mr. Wood, and he served as its first chairman for a period of seven years. He also served on the Machine Survey Committee.

Polytechnic Institute of Brooklyn. His principal research and development projects have been in the field of heat transfer.

Vincent J. Cushing, a rocket and missiles expert, has been named manager of the propulsion and structural research department at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. He has been assistant manager of the department since January, 1954.

Harry C. Brown has been named chairman of the Division of Engineering at Lowell Technological Institute.

New Officers. American Management Association officers for fiscal year 1955–1956 were elected by the board of directors September 14. Those named, all of them re-elected, are the following: Chairman of the board, John M. Hancock, partner, Lehman Brothers, New York, N. Y.; chairman of the executive committee, Don G. Mitchell, chairman of the board and president, Sylvania Electric Products, Inc., New York, N. Y.; treasurer, James L. Madden, second vice-president, Metropolitan Life Insurance Company, New York, N. Y.; president, Lawrence A. Appley, Affiliate ASME; vice-president and general manager, James O. Rice; and secretary, Kenneth B. Ehlers. The last three are full-time staff members of the association.

Maurice L. Dickinson, chief hydraulic engineer for Bechtel Corp., has been elected president of the Engineers Club of Los Angeles (Calif.). J. Calvin Brown, past-president and Fellow ASME and past-president of the Engineers' Council of Los Angeles, Calif., was unanimously elected to serve as chairman of the board.

Other Society News. Plans for a Technical and Scientific Center in Houston, Texas, were announced September 14, after a meeting of the board of directors of the Houston Engineers Club.

The new Center, sponsored by the Engineers Club, will provide space and professional services for the more than 9000 members of Houston's 35 technical societies and engineering groups. The Center will be at the site of the present Engineers Club. A $300,000 rebuilding program will transform the older building and provide spacious conference halls, lecture halls, reading and reference room, dining and banquet rooms, storage spaces, and offices for the Houston Engineers Club.

Of special significance to Houston is the fact that the Technical Center will bring together the many and highly diversified technical fields in this area—engineers of all professional branches, architects, chemists, and scientists. Houston and its Technical Center will provide the common meeting place and a unique opportunity for interchange of ideas among top specialists in many highly technical fields.

The Society of Industrial Designers has voted to change its name to American Society of Industrial Designers, Peter Muller-Munk, president, announced on October 6. The announcement came at the opening session of the ASID three-day design conference and eleventh annual meeting at The Woodner Hotel, Washington, D. C.

Besides organizing the exhibit which was shown in Liege, Belgium, and later in Paris, France, and Barcelona, Spain, as part of President Eisenhower's Trade Fair Program, ASID has also planned three tours of foreign designers through the United States, during the past year. Five of its members have been chosen by the International Co-Operation Administration to work with under-industrialized countries in Asia, Africa, and South America to improve design and merchandising techniques of their produce.

The ASID Design Conference considered motivation research, the design of heavy industrial equipment, and automation's effect on industrial design during the meeting. Besides members and industry guests, the conference was attended by a group of European design specialists under International Co-Operation Administration sponsorship.

Titanium Attains Distinguished Scholastic Status at NYU

Leading Titanium Authorities Gather to "Teach School" Complete With Exam

Titanium's use in jet engines explained at NYU conference. M. E. Cieslicki, General Electric research engineer, diagrams phase of titanium application in jet-aircraft engine. He was one of 22 national authorities who addressed 140 participants from industry and research laboratories throughout the United States and from England and Canada.

Titanium, the postwar metal that started off in high gear but has now throttled down to less spectacular but more practical progress, added another notch to its prestige recently by winning the red-carpet treatment on an academic campus.

At the New York University College of Engineering from September 12 to 16, the nation's leading authorities on every aspect of titanium research and technology gathered to teach school. The school—an intensive series of 25 lectures—was sponsored by NYU's metallurgical engineering department, and the University's Office of Special Services to Business and Industry, together with the American Society for Metals Engineering Institute.

Although the program was strictly education in format (including a written test—albeit with answer sheet provided) talk in the lecture hall and in corridors and lounges inevitably got around to the puzzlers that have marked titanium's career since infancy. Where is titanium going? And is it worth all we're putting into it?

The questions took on added meaning, when, in the midst of the week-long series, word came from Washington that the Government was cutting down subsidies for production of sponge titanium. Reason: More raw material on hand than industry needs, including reserves.

But the Government isn't stepping out of titanium by a long shot. The "class" at NYU heard N. E. Promisel, chief metallurgist and materials head of the Navy Bureau of Aeronautics, predict that the Department of Defense is planning a large research and development program at least equal to its program of the past 10 years. Moreover, Mr. Promisel said, the Government will, before 1956, initiate an extensive titanium sheet-rolling program involving "millions of dollars" and "aiming to serve as a connecting link between laboratory work and industrial application."

Titanium's cost handicap will "definitely" be reduced, Mr. Promisel added. The price of $5 per lb, which stayed firm for many years, has begun to fall. Titanium in the price range of $1 to $1.50 a pound is foreseen, but not in the next few years, he said.

While titanium usage continues heaviest in the aircraft industry, more nonmilitary industrial applications were forecast by Dwight W. Kaufman, eastern sales manager of Rem-Cru Titanium, Inc.

Titanium Applications

"Today's applications," he said, "have been restricted by ignorance of titanium's possibilities, the long time required for most service tests, high initial costs, and lack of availability of such things as castings, pipe, and fittings."

However, he went on, "Industry is beginning to recognize the potentials of this unique metal." Prices are being reduced and titanium castings, flarable tubing, welding fittings, and other special items are reaching the market.

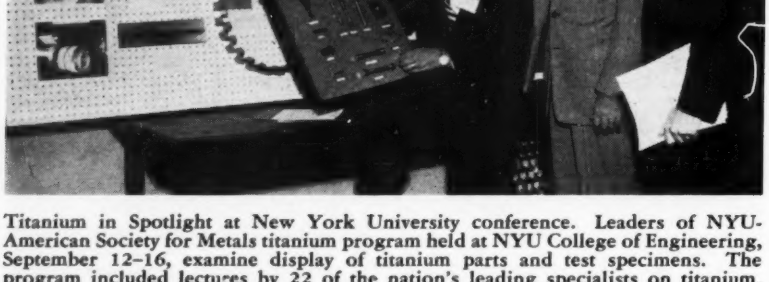
One of the obvious markets is the commercial airplane, Mr. Kaufman said. Use of titanium on the DC7-C is greater than in the DC7, in which it saved 200 lb per plane. The chemical industry is another key market, he said. Titanium keeps equipment operating, permits utilization of new and improved processes, and prevents contamination of solutions by the products of corrosion of previously used less-resistant materials.

In the paper-pulp industry and others using chlorine dioxide as a bleaching agent "titanium looks like the answer to a prayer." Titanium nozzles have lasted 13 months where best material previously lasted $5\frac{1}{2}$ hr. In food-handling industries, titanium will increase the life of canning equipment exposed to brines and of cooking equipment for pickles, condiments, and the like.

Corrosion resistance also makes titanium valuable in shipping, pleasure-craft, and dockside equipment. Other outlets for the new metal are electronics (rectifiers), surgery (prosthetics), and all forms of land transportation, Mr. Kaufman said.

Before rising from the production plateau of 1200 tons a year, the titanium industry must produce 180,000 psi minimum ultimate tensile-strength forgings and nearly that strong sheet, said Walter L. Finlay and W. W. Wentz of Rem-Cru. Only heat-treatment can bring the metal to this level.

Lee S. Busch of Mallory-Sharon Titanium Corporation outlined the prospects for mill products of titanium. Pressing, forging, rolling, drawing, and extruding have all been performed with some success on titanium and its alloys. However, said Mr. Busch, how the final properties of titanium are affected by



Titanium in Spotlight at New York University conference. Leaders of NYU-American Society for Metals titanium program held at NYU College of Engineering, September 12–16, examine display of titanium parts and test specimens. The program included lectures by 22 of the nation's leading specialists on titanium. *Left to right*, John P. Nielsen, chairman of the NYU department of metallurgical engineering; Anton De S. Brasunas, director of the ASM Metals Engineering Institute, Cleveland, Ohio; and Harold Margolin, NYU titanium research project director.

rates and modes of deformation, either hot or cold, is at best incompletely understood.

The metal's tendency to absorb hydrogen rom both gaseous atmospheres and chemical cleaning baths is the most troublesome knot in processing, he said. Alloys with consistent properties have been particularly difficult to make in sheet form. Mr. Busch was confident, nevertheless, that the mechanical metallurgy of titanium would be worked out when titanium is fitted in economy as a readily available metal with consistent and specified properties.

Reducing Titanium Cost

Another possible avenue for reducing the cost of titanium was proposed by Arthur Schwope of Clevite Research Center, Cleveland, Ohio. Powder metallurgy, he said, can reduce processing costs by minimizing scrap and machining operations. Because the increased surface area of powder increases danger of contamination by oxygen and nitrogen, titanium-powder metallurgy is in some respects more complicated than melting. But the potential reward warrants full investigation of this approach, he said.

Although considerable attention was devoted to the difficulties and stumbling blocks in titanium development and production, one of its highly attractive characteristics was spelled out in detail. That is resistance to high temperatures. "We are getting into the temperature range (in flight) where aluminum and magnesium alloys begin to lose their strength rapidly," said Mr. Promisel. "Either steel, with its high density and therefore weight penalty, must be used or hopes must be based on such alternatives as titanium alloys." M. E. Cieslicki of General Electric and H. D. Kessler of the Titanium Metals Corporation of America discussed elevated-temperature properties of titanium alloys in detail.

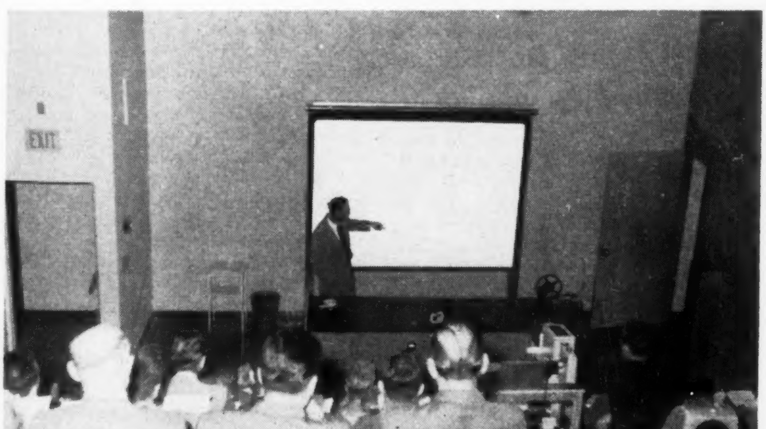
Perhaps the most significant clue to titanium's future, stated John Nielsen, chairman of NYU's metallurgical-engineering department, after the program, was the popularity of the titanium school. To keep the class within workable bounds, registration ended August 20 with 140 engineers and sales personnel from the United States, Britain, and Canada. Many others had to be turned away.

A written opinion poll taken of those attending demonstrated the school's value and Dr. Nielsen and Dr. Harold Margolin, who directs NYU's titanium research, say it will probably be repeated. Exact details still have to be worked out.

ASME Western Applied Mechanics Conference Held at the U. S. Naval Postgraduate School

Flanked by the old Del Monte Hotel building still bearing the imprint of its one-time luxury, and in a setting of nearly every type of tree known to grow in the middle coastal area of California, the 1955 ASME Western Conference in Applied Mechanics was hosted during September 12 and 13 by the United States Naval Postgraduate School on beautiful Monterey Bay in California.

A group of about 60 registrants enjoyed a well-conceived program of research papers and admired the broad expanse of glass-walled laboratory classrooms and office buildings in a contemporary design.



Shown is a group attending a lecture by H. A. Lang, The Rand Corporation, during the fifth Western Conference of the Applied Mechanics Division of ASME held at the U. S. Naval Postgraduate School, Monterey, Calif., September 12 and 13. Mr. Lang spoke on the affine transformation of orthotropic plane-stress and plain-strain problems.

Papers on wave propagation, properties of materials, vibrations of nonlinear and variable parameter systems, and large deflection theory of plates were presented and discussed enthusiastically. About 42 of the participants joined in the Applied Mechanics luncheon.

Most of the papers were distributed at the meeting in preprint form and will appear in the *Journal of Applied Mechanics*.

Joint participation of The American Society of Mechanical Engineers, Applied Mechanics Division, and the American Society of Chemical Engineers, Engineering Mechanics Division, in this Western Conference, initiated in 1954, was continued in 1955 and is being planned for 1956.

ASME papers for the Western Conference are reviewed through the West Coast Committee according to the same high standards that are maintained by the National Applied Mechanics Division. Acceptance by the West Coast Committee connotes the same rights and privileges for a paper as does acceptance by the national body. Such papers are published in the *Journal of Applied Mechanics*.

Prospective authors and those interested in attending the 1956 conference should bear in mind that this conference will be held at the California Institute of Technology, Pasadena, in June, 1956.

Presentations are not restricted to West Coast authors. Midwest and eastern authors are welcome to submit papers for review for presentation at the Western Conference. Appropriate subjects are: Dynamics, vibrations, elasticity, plasticity, properties of materials, and nonlinear mechanics.

ASME papers may be sent to Jack L. Alford, Secretary, West Coast Committee, Technicolor Motion Pictures Corporation, 6311 Romaine Street, Hollywood, Calif.

Trade Fair of the Atomic Industry to Chicago for 1956

Plans to hold the second Annual Trade Fair of the Atomic Industry at the Morrison Hotel in Chicago in September, 1956, were announced by the Atomic Industrial Forum. The Trade Fair will be held in conjunction with the Forum's Annual Fall Meeting and will serve as the nation's primary atomic market place.

The first U. S. Trade Fair of the Atomic Industry, also under Forum sponsorship, was held September 27–30 at the Sheraton-Park Hotel in Washington, D. C. More than 70 American and foreign industrial firms along with several U. S. and foreign government agencies and research contractors took part in the 1955 event. For 1956, the Forum has reserved larger space in anticipating even greater participation from industrial organizations engaged in advancing the application of nuclear energy for constructive purposes.

The Atomic Industrial Forum numbers more than 350 organization members, among them many of the world's leading manufacturers of nuclear reactors, reactor components and auxiliaries, fuel processors, and instrument makers, in addition to leading research laboratories, educational institutions, and labor organizations.

Morning-session speakers at the symposium on "The Role of the Small Gas Turbine," Saturday, October 1, in the auditorium of the Engineering Societies Building: *Left to right,* A. A. Hafer, Assoc. Mem. ASME, manager, Product Planning and Marketing Research, General Electric Company; Session Chairman W. H. Byrne, vice-president, ASME Region II, president of Byrne Associates, New York. N. Y.; P. F. Martinuzzi, Mem. ASME, professor of mechanical engineering, Stevens Institute of Technology; and H. A. Fremont, manager and staff member, Combustion Section Components Development, General Electric Company. The symposium was one of the closing events of a year-long celebration of the centennial of the Polytechnic Institute of Brooklyn. It was sponsored by Polytechnic's department of mechanical engineering in co-operation with the Metropolitan Section of the ASME, currently marking its 75th anniversary year; and the Metropolitan Section of the SAE, now celebrating its 50th anniversary year.

Symposium on Small Gas Turbines Climaxes Brooklyn Poly's Centennial Year

ASME and SAE join Institute in presenting symposium

The Polytechnic Institute of Brooklyn offered the final technical meeting of its centennial celebration, a symposium on "The Role of the Small Gas Turbine," held October 1, 1955, in the auditorium of the Engineering Societies Building, New York, N. Y.; the Metropolitan Sections of both The American Society of Mechanical Engineers and the Society of Automotive Engineers, celebrating their 75th and 50th year, respectively, joined to make this symposium an outstanding event.

Technical Sessions

Three technical sessions, at which ten papers were presented, were held during the day. More than 250 scientists and engineers attended. W. H. Byrne, vice-president, ASME Region II, was chairman of the morning session. Benjamin Pinkel, head, Material and Thermodynamics Division, National Advisory Committee for Aeronautics, conducted the afternoon session. The evening session had R. R. Peterson, Assoc. Mem. ASME, head, Gas Turbine Section, Bureau of Ships, Navy Department, as chairman. The conferees were welcomed by Harry S. Rogers, Mem. ASME, president, Polytechnical Institute of Brooklyn. The Symposium Committee consisted of the following personnel: Jerome Bartels, Mem. ASME, chairman; Philip Chaikin; Herman Grau, Assoc. Mem. ASME; and C. A. Wojan, Assoc. Mem. ASME.

Morning Session

P. F. Martinuzzi, Mem. ASME, professor of mechanical engineering, Stevens Institute of Technology, in his paper, "The Small Industrial Gas Turbine," discussed the application of this type of turbine. The recent automotive advantages illustrated by use of small gas turbines in heavy trucks emphasizes savings on weight and space in transmission. In addition the ratio between starting and design torque is very close. He disclosed that in England the small gas turbine, with a blower, is used to quell waves in water. He added that the small gas turbine is used in fire pumps and compressed-air generators. While the present thermal efficiency is presently low, work is under way to improve the thermal efficiency by use of heat exchangers. Heat-exchanger design, he added, is one of the big problems to be solved.

A. A. Hafer, Mem. ASME, product planning and marketing research, General Electric Company, speaking on "Cycle Arrangements and Exhaust Heat Recovery for Small Gas-Turbine Units," took up the following application. The use of exhaust of a small gas turbine to feed a power boiler so that high-temperature air can be used, thereby eliminating the air-preheater section of the boiler. Again, there is a saving of space and of an expensive piece of equipment.

H. A. Fremont, manager and staff member, Combustion Section Components Development, General Electric Company, "Combustion in Small Gas Turbines," discussed the problems of burning fuels in combustion. He took up two phases of the problem: Vibration of gases and fuel-spray patterns.

Afternoon Session

W. W. Chao, Assoc. Mem. ASME, Heat Exchangers Section, gas-turbine department, Scientific Laboratory, Ford Motor Company, was first speaker of the afternoon session. His paper discussed one of the solutions of the heat-exchanger design to improve the thermal efficiency of small gas turbines. He told of his analytical method for determining optimum design parameters.

"Noise Problems of Small Gas Turbines" was the title of R. O. Fehr's talk. Dr. Fehr, consulting engineer, General Engineering Laboratory, General Electric Company, covered the work being done in noise control of jet-plane take-off.

L. L. Berggren, Engine Controls Section, Minneapolis-Honeywell Regulator Company, in his paper "Controls for Small Gas Turbines," told of a system of monitoring fuel supply to the engine relative to atmospheric and flight conditions in a jet plane.

J. J. Harwood, head, Metallurgy Branch, Office of Naval Research, Navy Department, speaking on "New High-Temperature, High-Strength Super Alloys," discussed the new materials, such as cermets, titanium, molybdenum, and the application of these alloys to small gas-turbine components.

Evening Session

The evening session opened with L. Kingston's paper "Dynamic Loading of Transmissions." Mr. Kingston, senior staff design engineer, Piasecki Helicopter Corporation, spoke on the problems of gearing and transmission of high-speed, high-torque transmission.

H. C. Hill, assistant chief project engineer, Boeing Aircraft Company, presented a paper

"Development and Operating Experiences of Boeing's Model 502 Small Gas Turbine." On the West Coast, Mr. Hill stated, the Model 502 has been used in trucks to replace diesel engines; it has been used to drive a small electric generator at one of the Navy installations; it has been used in the Air Force to drive a small air compressor as well as a small ground-starting cart used with the B-52.

In the concluding talk by A. T. Gregory, chief engineer, Fairchild Engine Division, Fairchild Engine and Airplane Corporation, projected the data to year 1965 in the small turbojet field. Data of production and performance of small turbojets showed probable decrease of approximately 40 per cent in specific fuel consumption and increase in compressor pressure ratio from 2.5 to 4 in 1955 to approximately 8 by 1965.

Ford Company Maps Research Expansion

In Detroit on October 5, the Ford Motor Company announced plans for a $50-million expansion of its research and engineering center in Dearborn, Mich.

Ernest R. Breech, chairman of the company's board, said Ford's emphasis on research and engineering had paid off in public acceptance of its products. A. A. Kucher, director of the scientific laboratory of the company's engineering staff, discussed the future of the gas-turbir engine. He predicted that a substantial number of passenger vehicles would be equipped with such engines within ten years.

The company displayed a futuristic research auto called the "Mystere." The long, low car features a hinged bubble-type glass-roofed canopy, a steering wheel that can be put in front of either front-seat occupant, and a rear engine compartment designed for a gas turbine or conventional engine.

Afternoon-session speakers: *Left to right,* W. W. Chao, Assoc. Mem. ASME, supervisor, Combustors and Heat-Exchangers Section, gas-turbine department, Scientific Laboratory, Ford Motor Company; Session Chairman Benjamin Pinkel, head, Material and Thermodynamics Research Division, National Advisory Committee for Aeronautics; Lloyd E. Berggren, Engine-Controls Section, Minneapolis-Honeywell Regulator Company; and J. J. Harwood, head, Metallurgy Branch, Office of Naval Research, Navy Department

Evening-session speakers: Session chairman Roy R. Peterson, *right,* Assoc. Mem. ASME, head, Gas Turbine Section, Bureau of Ships, Navy Department and Henry C. Hill, assistant chief project engineer, Boeing Aircraft Company

Meetings of Other Societies

Nov. 3–4
Society for Advancement of Management, measurement of management conference, Hotel Statler, New York, N. Y.

Nov. 16–18
Steel Founders' Society of America, annual technical and operating conference, Hotel Carter, Cleveland, Ohio

Nov. 17–18
American Society for Quality Control, tenth Mid-West Conference, Hotel Schroeder, Milwaukee, Wis.

Nov. 27–30
American Institute of Chemical Engineers, annual meeting, Hotel Statler, Detroit, Mich.

Nov. 28–Dec. 1
Air-Conditioning and Refrigeration Institute, exposition of the air-conditioning and refrigeration industry, Auditorium, Atlantic City, N. J.

Nov. 30
British Nuclear Energy Conference, inaugural meeting (an organization formed by the Institutions of Civil, Mechanical, Electrical, and Chemical Engineers and the Institute of Physics), London, England

Dec. 1–3
American Society of Refrigerating Engineers, annual meeting, Traymore Hotel, Atlantic City, N. J.

Dec. 4–7
American Society of Agricultural Engineers, winter meeting, Edgewater Beach Hotel, Chicago, Ill.

Dec. 5–9
Second Combustion Colloquim, University of Liege, Liege, Belgium

Dec. 5–9
Twenty-fifth Exposition of Chemical Industries, Commercial Museum and Convention Hall, Philadelphia, Pa.

(*ASME Calendar of Coming Events, see page 1020*)

P. E. Frank, *right,* chairman, Petroleum Division, ASME, presenting a certificate of award to M. A. Scheil, secretary of the Petroleum Division at the banquet, Tuesday evening, September 28

O. L. Lewis, *left,* receiving award from P. E. Frank, chairman, ASME Petroleum Division, in recognition of Mr. Lewis's five-year term on the Executive Committee and its chairman in 1954

H. H. Meredith, Jr., *left,* accepting an award from the Petroleum Division, ASME, from P. E. Frank, chairman, in recognition of his contribution to the Division

Tenth ASME Petroleum Mechanical Engineering Conference a Great Success

A "Get-Acquainted" Reception, attended by over 400 persons, with the showing of three movies, entitled "The New New Orleans," "The Good Neighbor Port," and "The Mechanical Engineer," plus an abundance of refreshments, opened The American Society of Mechanical Engineers Petroleum Division's tenth annual conference in New Orleans, La., the evening of September 25, 1955. With standing room only at all of its technical sessions and social functions, the conference was a great success technically, socially, and publicitywise.

The Welcoming Luncheon on Monday, at which ASME President David W. R. Morgan gave a most interesting and informative address on "The Future of Power Generation," was attended by a capacity audience. The three New Orleans newspapers gave full daily coverage to the entire conference.

Thirty-two outstanding papers and three panel discussions were presented at the seventeen technical sessions. The 609 registrants provided standing room only at all sessions.

A most enjoyable social event was the complimentary cocktail party given by the New Orleans Section of ASME at the Engineers' Club of New Orleans, Monday evening, September 26, for all conference registrants and their guests.

The climax of the social functions was the banquet, Tuesday evening, at which Henry J. Voorhies, vice-president of Esso Standard Oil, gave an excellent address to the capacity audience on "Oil and Louisiana."

The conference closed with an inspection trip to Shell Oil Company's Norco Refinery and American Cyanamid Company's Fortier Plant on Thursday, September 28.

The success of this conference was due to the wonderful preparation and untiring efforts of the New Orleans Section of ASME.

Availability List for 1955 ASME Petroleum Mechanical-Engineering Conference

The papers in this list are available in separate copy form until July 1, 1956. Please order only by paper *number;* otherwise the order will be returned. Copies may be purchased from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.; 25 cents per copy to ASME members; 50 cents to nonmembers.

Paper No.	*Title and Author*
55—PET-1	Yield and Bursting Characteristics of Heavy-Wall Cylinders, by J. H. Faupel
55—PET-2	Thermal Cycling Test of a Hot Spot on a Vessel, by P. N. Randall and H. A. Lang
55—PET-3	Consumable Insert Technique for Pipe Welding, by R. D. Thomas, Jr.
55—PET-4	Developments in Instrumentation by the Petrochemical Industry, by R. G. Marvin, W. L. Stuart, G. W. Lunsford, and E. E. Ludwig
55—PET-5	Future Trends in Automation, by G. G. Gallagher and R. A. Robinson
55—PET-6	Fluid-Coker Mechanical-Design Aspects, by R. H. Maas and E. J. Newchurch
55—PET-7	Orthoforming—An Application of the Fluid-Solids Technique to Catalytic Reforming, by M. R. Smith
55—PET-8	Control of Pulsations in Piping Systems, by C. Newman and N. H. Moerke
55—PET-9	A Pressure-Drop Correlation for Turbulent Two-Phase Flow of Gas-Liquid Mixtures in Horizontal Pipes, by J. M. Chenoweth and M. W. Martin
55—PET-10	High-Pressure Expansion-Joint Studies, by S. R. Kleppe
55—PET-11	Control of Refinery Maintenance and Construction Costs, by E. C. Newton and M. A. Conetta
55—PET-12	Some Cases of Stress Due to Temperature Gradient, by D. J. Bergman
55—PET-13	Fire-Protection Equipment for Pipe Lines and Terminals, by A. L. Dunlop
55—PET-14	Batching Natural Gasoline Through Crude Oil Lines, by C. N. Adams
55—PET-15	Radiographic Inspection of Lead Linings, by W. Skiba and V. P. Bracken
55—PET-16	Progress of Turbodrill Development in California, by W. R. Postlewaite
55—PET-17	The Operation of Compressor Cylinders Without Cooling Water, by J. L. Gallagher and H. W. Evans
55—PET-18	Ebullition Cooling of Gas Engines, by G. O. Bates, J. E. English, and G. M. Franklin
55—PET-19	Tennessee Gas-Transmission Company Proves Process for Low-Temperature Gasoline Extraction, by R. V. Mertz
55—PET-21	Hydraulic Pumping Units—an Engineering Look at the Big Ones, by Douglas M. Jones
55—PET-22	Photoelasticity, a Useful Tool for the Oil-Tool Designer, by W. M. Koch
55—PET-23	Soil Mechanics Applied to Mobile Drilling Structures, by B. McClelland, J. A. Focht, Jr.
55—PET-24	Practices in Displacing Liquid Hydrocarbons From Pipe Lines, by S. C. Phelps
55—PET-25	Volume Shrinkage Occurring in Blending Petroleum Products and Produced Distillates With Crude Oils, H. M. Childress and M. B. Grove
55—PET-26	Offshore Mooring of Drilling-Rig Tenders, by R. P. Knapp and H. V. Wait
55—PET-27	Effect of Thin-Walled Cylinders of Combined Loading From Tension and External Slip Compression, Part 1; and Application to the Problem of Oil-Well-Casing Suspension, Part 2, by A. F. Rhodes and J. C. Wilhoit

55—PET-28 Tool-Joint Thread Lubricant, by C. H. Dragert
55—PET-29 Pressure Drop for an Evaporating Fluid in a Tubular Heater, by Frank L. Maker
55—PET-31 High-Temperature Stability of Insulating and Refractory Castables in Reducing and Oxidizing Atmospheres, by C. M. Vogrin and H. Heep
55—PET-32 Offshore Construction, by C. L. Graves

Availability List for 1955 ASME IRD Conference

The papers in this list are available in separate copy form until July 1, 1956. Please order only by paper *number;* otherwise the order will be returned. Copies may be purchased from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.; 25 cents per copy to ASME members; 50 cents to nonmembers.

Paper No.	*Title and Author*
55—IRD-9	Process Control by End-Point Analysis and Associated Data-Reduction Systems, by S. M. Rock and J. Walker
55—IRD-10	Study of Pneumatic Processes in the Continuous Control of Motion With Compressed Air, Part 2, by J. L. Shearer
55—IRD-11	The Differential Refractometer for Automatic Control of Fractionating Columns, by O. W. Larrison, F. W. Purl, and H. R. Harris
55—IRD-12	Automation, Its Effect Upon the Future of the Process Industries, by I. C. Bechtold
55—IRD-13	An Automatic Logging and Computation System for an Industrial Process, by R. J. Marmorstone

Early Planning for 1956 Engineers' Week Under Way

Preliminary planning and production work on promotional materials for National Engineers' Week, Feb. 19–25, 1956, is already well under way. Information is now being compiled from questionnaires on the uses and values of the material sent out from the National Society of Professional Engineers for the 1955 National Engineers' Week observance.

The two-page questionnaires were sent to all chapter presidents with a letter of transmittal asking that they be filled out by Engineers' Week Committee Chairmen for the 1955 event. Answers given on the questionnaires would be used in determining the type of material to be included in the kits for the 1956 program.

Engineers' Week Sponsors

The following are the sponsors for the 1956 National Engineers' Week: Vannevar Bush, president, Carnegie Institution of Washington; Allen B. DuMont, president, Allen B. DuMont Laboratories, Inc.; Charles F. Kettering, Fellow ASME, General Motors Corporation; Clarence H. Linder, Mem. ASME, vice-president, General Electric Company; Thomas E. Murray, Fellow ASME, Commissioner, U. S. Atomic Energy Commission; Royal W. Sorensen, California Institute of Technology; Philip Sporn, Hon. Mem. ASME, president, American Gas and Electric Company; David B. Steinman, consulting engineer; Charles Allen Thomas, president, Monsanto Chemical Company; and Robert E. Wilson, chairman of the Board, Standard Oil Company of Indiana.

Social Event

A feature of the 1956 Week will be a special dinner sponsored by NSPE in Washington, D. C., in conjunction with the Board of Directors' meeting to be held in that city during Washington's Birthday week. Leading engineering and political figures will be honored at the dinner.

Dedication ceremonies for the new NSPE headquarters building in Washington will also be held during the week of February 19–25.

U of P Marks Hundredth Year of Engineering Instruction

One hundred years of engineering instruction at The University of Pennsylvania will be marked by a "Centennial Symposium on Modern Engineering," on Friday, November 11, it was announced by Carl C. Chambers, vice-president for engineering affairs.

"We have spanned a century of technological revolution, in which Pennsylvania's faculties, alumni, and laboratories have at times been privileged to perform historic roles," Dr. Chambers said.

"The extent of this revolution is symbolized by the subject matter of the Centennial Symposium—nuclear engineering, automation, computer development, operations research, and human materials."

Symposium sessions will be held at 10:00 a.m. and 2:00 p.m. in the University Museum Auditorium, 34th and Spruce Streets, Philadelphia, Pa. Scheduled speakers and their topics are:

Charles H. Weaver, Mem. ASME, vice-president in charge of Atomic Power Division, Westinghouse Electric Corporation, "The Engineering of Nuclear Power Plants"; Granville M. Read, Mem. ASME, chief engineer, E. I. du Pont de Nemours & Co., Inc., "The Profile of Human Materials"; Elmer W. Engstrom, executive vice-president for research and engineering, Radio Corporation of America, "Automation"; Jay W. Forrester, director of computer research, the Massachu-

During the tenth annual Instrument Society of America Instrument-Automation Conference and Exhibit, September 12–16, Los Angeles, Calif., a dinner was held at the Biltmore Hotel for the ASME members who were attending the Society's IRD sponsored sessions. L. J. Ortino, *standing in left photo,* Mem. ASME, chief mechanical engineer, special products department, Beckman Division, Beckman Instruments, Inc., Fullerton, Calif., and conference chairman of ASME, was master of ceremonies at the dinner, September 12. John F. Bishop, *standing in right photo,* Assoc. Mem. ASME, assistant general manager, Beckman Instruments Division, Beckman Instruments, Inc., South Pasadena, Calif., was the speaker of the evening. His paper, "Instrumentation of the Future," discussed plans for development and research.

setts Institute of Technology, "The Engineering of Modern Computers"; and Ellis A. Johnson, director of the Army's Operations Research Office of The Johns Hopkins University, "Operations Research."

Dr. Gaylord P. Harnwell, president of the University, who is an atomic physicist, will greet the guests. Cosponsoring the symposium are the Philadelphia sections of several national technical societies. All engineers are invited to attend.

Engineering education at Pennsylvania dates back to the establishment of civil-engineering courses by the late Prof. Fairman Rogers in 1855. The University today has five engineering schools—the Schools of Chemical, Civil, Mechanical, and Metallurgical Engineering and the Moore School of Electrical Engineering.

Its achievements include the development of ENIAC, the first large-scale, general-purpose, electronic digital computer, which was completed by the Moore School 10 years ago.

Need for Mechanical Engineers Grows

U. S. Naval Engineering Experiment Station

The U. S. Naval Engineering Experiment Station, Annapolis, Md., the Navy's oldest research and development laboratory, has a vacancy for the position of supervising marine power-plant test engineer at $8990 a year.

The duties of the position are: Co-ordinates the technical and administrative functions of a section assigned to the evaluation and development of gas-turbine engines for use aboard naval vessels. Supervises and directs the work of engineers and subprofessional personnel in the preparation of design studies, conduct of tests, preparation of test agendas, analysis of data, procurement and manufacture of specialized equipment, facility installation, and preparation of technical reports.

Applicants should have at least four years of appropriate experience at a commensurate level, in addition to the usual educational background. File applications by November 21 with the Industrial Relations Office, U. S. Naval Engineering Experiment Station, Annapolis, Md.

NACA Seeks Mechanical Engineers

The National Advisory Committee for Aeronautics is offering varied employment opportunities in many fields of aeronautical research for both recent graduates and experienced engineers. Some of the current problems are: Supersonic aerodynamics; power-plant installation; viscous flow and separation; blading and cascades; mixed flow; compressor and turbine research.

Application of combustion fundamentals to engine design; fuel injection and turbulence mixing.

Aerodynamic instruments for high-velocity compressible gas streams; hot-wire anemometry; electronic analog computers for theoretical studies.

Full-scale engine research to measure performance of turboprop, turbojet, and ramjet engines at high speeds and extreme altitudes; thrust augmentation and thrust reversal; studies of dynamics, instability, and response rates of automatic controls; tip-burning pressure jets for rotorcraft; vertical take-off aircraft.

Nuclear-reactor analysis for aircraft propulsion; heat-transfer rates and media; shielding, cooling, and waste disposal; lubrication and wear of bearings.

Stress and vibration analysis of gas-turbine components; improvement of critical parts; high-temperature material research.

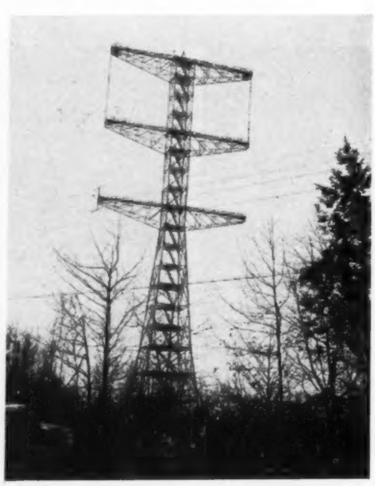
Rocket research; evaluations of potential rocket fuels and high-energy aircraft turbine fuels for extended range, speed, and altitude.

These positions offer challenging experimental and theoretical assignments, a professional atmosphere among experts, and recognition on a national and even international level. Excellent opportunities for creative research. Salaries are commensurate with qualifications and assignments. Advanced study is encouraged and may be pursued while in full-pay status. Ample leave and other fringe benefits are provided.

Further information may be obtained by writing: NACA, Lewis Flight Propulsion Laboratory, Room 350 ASB, 21000 Brookpark Road, Cleveland 11, Ohio.

Columbia Acquires Armstrong Field Laboratory for Radio

The acquisition by Columbia University for its School of Engineering of the huge steel radio tower on the bank of the Hudson, fourteen miles from New York City at Alpine, N. J., was announced September 29 by John R. Dunning, Mem. ASME, dean of the Engineering School.



Transmitting Tower recently acquired by Columbia University. Prof. E. H. Armstrong's transmitting tower, a 400-ft-high structure rising 900 ft above sea level, as seen from route 9W near Alpine, N. J., on the Palisades.

The familiar landmark opposite Yonkers, N. Y., together with its permanent brick laboratory building, was acquired from the estate of the late Major Edwin H. Armstrong, the inventor of FM radio and long a professor of electrical engineering at Columbia. The installation will be known as the Edwin H. Armstrong Field Laboratory and will be used by the department of electrical engineering for research in radiation and propagation of various types of radio waves, particularly with respect to their behavior in the atmosphere, ionosphere, and upper atmosphere.

In addition to the Alpine site, Columbia University also has acquired from the Armstrong estate 57 acres of land in the towns of Catskill and Hunter, N. Y. This area includes one of the taller peaks of the Catskill Mountains. These two sites, plus Columbia's engineering camp near Litchfield, Conn., will form a triangular range for extensive field studies in radar and radio.

"This unique tower with its three crosstrees 900 ft above sea level," Dean Dunning said, "is to be used for research sponsored by the department of electrical engineering and will be available for projects of the Armed Services and for industry. It will provide a valuable extension of the laboratory facilities in radio and electronics research to which Columbia already has contributed so much in the national interest."

John R. Ragazzini, executive officer of the Department of Electrical Engineering at Columbia, noted that "the addition of the Armstrong Field Laboratory will enable the department to enlarge its research program into fields hitherto inactive because of lack of a facility of this type. The department expects to carry on many of its researches in those areas for which the late Major Armstrong was best known.

"We consider ourselves extremely fortunate to be able to take advantage of this unique facility originally established by Major Armstrong," he concluded.

The famous tower and laboratory were built in 1938 at Alpine, N. J., by Major Armstrong to perfect frequency modulated radio transmission, probably the best known of his contributions to the electronics field. During World War II the station was also used in developments in the field of radar.

These new facilities will supplement the extensive electronics research laboratories at 125th Street near Riverside Drive, New York, N. Y., in the building which forms unit number one of the new Columbia University Engineering Center, and the Marcellus Hartley Laboratories on the Columbia campus.

Fritz Engineering Laboratory Dedicated at Lehigh

Lehigh University dedicated its new Fritz Engineering Laboratory and the world's largest universal testing machine October 14. The new building on the Bethlehem, Pa., campus, completed after three years of construction, also will house a dynamic testing bed featuring Amsler equipment unique in this country.

The new building consists of a seven-story section, 130 ft × 70 ft, and a four-story section,

114 ft × 24 ft. The main test bay of the new building measures 50 ft × 130 ft, houses the 5,000,000-lb testing machine and the Amsler repeated-load equipment. It is serviced by a 20-ton crane 65 ft overhead.

The original building, which was built in 1909, has been completely renovated. It has a test bay measuring 50 ft × 110 ft served by a 10-ton crane 35 ft overhead. This bay houses an 800,000-lb universal machine, and a 2,000,000 in-lb torsion machine. A variety of smaller tension, compression, torsion, impact, and hardness-testing machines as well as a complete variety of strain and deformation-measuring instruments are available.

Special laboratories for instruction, research, and testing in concrete, hydraulics, materials testing, soils mechanics, sanitary engineering, and structural models are provided. The concrete laboratory is equipped for making and curing all types of plain, reinforced, and prestressed concrete specimens. The hydraulics laboratory has three levels with pumps, tanks, turbines, weirs, and other apparatus for research and industrial tests. Space is available for special large-sized model tests of spillways, channels, and other hydraulic structures.

The Amsler equipment, manufactured in Schaffhouse, Switzlerland, consists of a completely integrated set of jacks, pumps, and load-measuring devices especially designed to apply and measure repeated loads on structures, structural members, or machine parts. The equipment will apply loads of up to 100 tons at a rate of 250 to 500 cpm.

The laboratory-machine shop is completely equipped with lathes, millers, drill presses, power saws and other equipment for the fabrication of test specimens and setups. The welding shop provides facilities for both electric-arc and gas welding.

The entire building includes a total of 39 offices with a normal complement of 60 people, a research library, two seminar rooms, and a photo dark room. The building is air conditioned and has a self-operated passenger elevator.

In Ottawa, October 5, a fountain and plaques commemorating Colonel John By of the Royal Engineers, who completed construction of the Rideau Canal in 1832, were unveiled. *Left to right* are: R. F. Legget, chairman, Ottawa Branch, The Engineering Institute of Canada; the Hon. R. H. Winters, Minister of Public Works; Brigadier J. L. Melville, Hon. Colonel Commandant, Royal Corps of Canadian Engineers; R. E. Heartz, Hon. Mem. ASME, EIC president; and Her Worship, Mayor Charlotte Whitten, Mayor of the City of Ottawa. The fountain and plaques are on the bank of the Rideau Canal in the heart of Ottawa. The fountain was designed by Sir Charles Barry, R. A., and stood in Trafalgar Square, London, England, from 1845 until 1948. It was presented to the National Gallery of Canada who made it available to the EIC for use as a memorial to Colonel John By.

Atoms for Peace Awards Established by Ford Foundation

On September 25 Henry Ford, 2nd, announced that James R. Killian, Jr., president of the Massachusetts Institute of Technology, will serve as chairman of the Organization and Planning Committee of Atoms For Peace Awards.

Committee Members

In addition to Dr. Killian, the committee will include Detlev W. Bronk, Hon. Mem. ASME, president of the Rockefeller Institute for Medical Research and president of the National Academy of Sciences; Ralph J. Bunche, undersecretary-general of the United Nations; Arthur H. Compton, professor, and former chancellor, Washington University; Mrs. Douglas Horton, formerly president of Wellesley College; Mervin J. Kelly, president of the Bell Telephone Laboratories; and Alan Waterman, director of the National Science Foundation, Washington, D. C.

Atoms for Peace Awards, announced by Lewis L. Strauss, chairman of the Atomic Energy Commission, in Geneva, Switzerland, on August 8, was established as a memorial to Henry Ford and Edsel B. Ford by a Ford Motor Company Fund appropriation of $1,000,000.

In Mr. Ford's announcement he stated that the Executive Committee of the Massachusetts Institute of Technology had approved his suggestion that the headquarters of the new institution be located at M.I.T.

The Organization and Planning Committee, under the leadership of Dr. Killian, has agreed to undertake the planning and organization of the Atoms For Peace Awards that will best assure the use of its funds during the next 10 years toward the application of atomic energy for the benefit of mankind.

In inviting Dr. Killian and the six distinguished members of his committee to accept this assignment, Mr. Ford expressed the hope that the committee "would set up the organization of the awards so that the organization would be an independent corporate entity, entirely separate and divorced from Ford Motor Company."

In informing Mr. Strauss of the establishment of the new institution on July 25, Mr. Ford described it as a response to the hope expressed by President Eisenhower at the July, 1955, meeting of the "Big Four" in Geneva that "private business and professional men throughout the world will . . . provide an incentive in finding new ways that this science can be used . . . for the benefit of mankind and not for destruction."

International Jury of Awards

Mr. Ford said at that time, "We would propose that when the organization of this new memorial fund is completed, the Board of Trustees of Atoms For Peace Awards appoint each year a competent international jury of awards for the purpose of selecting from among the world's scientists, inventors, and engineers —without regard for nationality or political belief—the individual or group of individuals who, in the jury's judgment, has made the greatest contribution during the year to peaceful uses of atomic energy; that the individual or group so selected be granted with appropriate ceremony the Atoms For Peace Award for that year; that the annual award carry, in addition to a suitable medal to be designed and cast for the purpose, an honorarium of $75,000; that, if during any year the International Jury of Awards or the Board of Trustees finds no candidates pre-eminently meriting the Atoms For Peace Award, the sum at the disposal of the memorial fund be used that year for scholarships and fellowships most likely to contribute to the advancement of the new science of peaceful application of atomic energy."

Junior Forum . . .

Conducted for the National Junior Committee by R. A. Cederberg,[1] Assoc. Mem. ASME

Engineering Education and the Professional Spirit

By Dr. Julius A. Stratton[2]

(Excerpts of particular interest to the younger engineer from a talk given at the New York University.)

In every age the patterns of education have reflected the temper of the times and the culture and character of a people. To some future historian the rise and development of engineering education will reveal those great currents of thought and striving that have dominated the nineteenth and twentieth centuries: The material triumphs, the philosophic conflicts, and the brooding spiritual doubts. It would be difficult to find a more fitting example of the evolving interplay between a society and its institutions. In the beginning the crude needs of freshly industrialized communities dictated the curriculums; and now new learning, generated and disseminated by our schools of science and engineering, is remolding and transforming society.

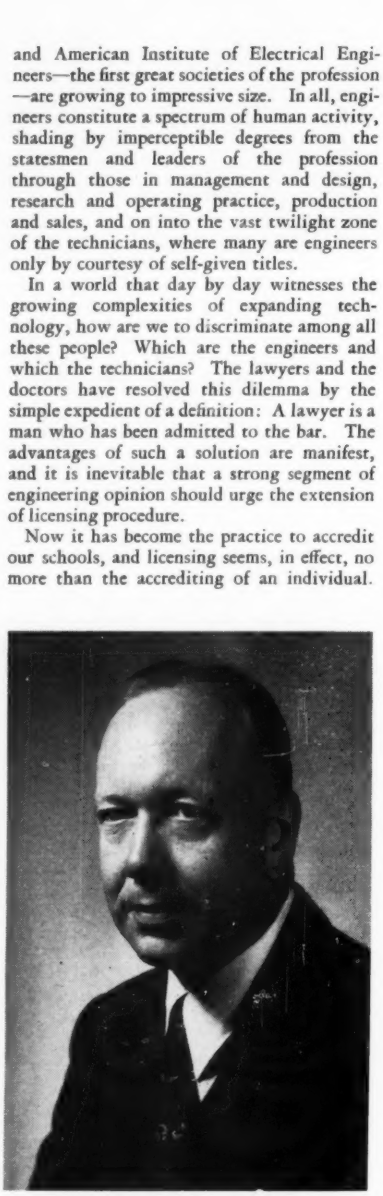
One-hundred years ago there were scarcely enough engineering graduates in all the country to exercise an appreciable influence upon our industrial growth. Thus in the years immediately following the Civil War the total enrollment in engineering at the New York University reached 39, while the entering class at the Massachusetts Institute of Technology in the fall of 1865 numbered only 72. By contrast, in the year 1954 some 214,000 were pursuing graduate and undergraduate engineering studies in 218 institutions, of which 150 are accredited at the professional level. And that imposing number, we are told, is wholly inadequate to satisfy the urgent needs of ever-expanding industry.

Founder Societies

To ascertain the total number of men—and women—who in this country pass today for engineers would be well-nigh impossible. There are, for example, some 104 nationwide engineering and allied organizations in the United States with a listed membership in the neighborhood of 750,000. There are more than 2500 local associations declaring engineering or technical aims with an untold membership. The Founder Societies, American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and American Institute of Electrical Engineers—the first great societies of the profession—are growing to impressive size. In all, engineers constitute a spectrum of human activity, shading by imperceptible degrees from the statesmen and leaders of the profession through those in management and design, research and operating practice, production and sales, and on into the vast twilight zone of the technicians, where many are engineers only by courtesy of self-given titles.

In a world that day by day witnesses the growing complexities of expanding technology, how are we to discriminate among all these people? Which are the engineers and which the technicians? The lawyers and the doctors have resolved this dilemma by the simple expedient of a definition: A lawyer is a man who has been admitted to the bar. The advantages of such a solution are manifest, and it is inevitable that a strong segment of engineering opinion should urge the extension of licensing procedure.

Now it has become the practice to accredit our schools, and licensing seems, in effect, no more than the accrediting of an individual.



J. A. Stratton, Vice-President and Provost of the Massachusetts Institute of Technology

Under the Engineers' Council for Professional Development, the accrediting process has been wisely administered and clearly has contributed to the rising standards of engineering colleges. But for all the good that stems from the concept of accreditation, one may discern also the latent seeds of a national disease—the mania to conform and to impose conformity upon others. This is a symptom to which every engineer who has a concern for the future of his profession should be alert. Whether accreditation and licensing shall become forces for good or for evil rests with the engineers alone—upon their wisdom, upon their capacity for statesmanship, upon their insight into the nature of engineering as a profession. For this idea of engineering as a profession in the highest sense, and of the engineer as a professional man, should have stronger roots than the mere bond of school or occupation.

What Is Engineering?

Engineering has been defined as the art and science by which the properties of matter and the sources of power in nature are made useful to man in structures, machines, and manufactured goods. Deeper than all such definitions are the processes of thought, the attitudes of mind, the sets of values that distinguish the engineer from the doctor, the lawyer—or the physicist. The engineer must have developed an innate sense and feel for the physical properties of matter and the operation of the fundamental laws of nature. He has a capacity to think in concrete terms; he resorts instinctively to numerical estimates, and he accepts the role of the empirical in the making of judgments. His reasoning is governed by concepts relating to the strength of materials, of factors of safety, of weight and form, of friction and efficiency, of the manifold limitations of pressure, temperature, and volume, of components and systems.

In greater or lesser measure, all engineers share these modes of thought and action—and so do the technicians. Only to the degree in which they have captured the professional spirit may we distinguish between them. It is a subtle, intangible quality not to be reduced to definition—an ideal toward which we aspire.

The common denominator of all conceptions of professional status, whether of medicine, law, or engineering, is a high sense of personal responsibility to client and to society, with a readiness to minister to the public welfare. A profession is, of course, based in some special field of learning, to be dealt with at a high intellectual level and involving intricate techniques. We take for granted this mastery by a professional man of the principles that underlie his special field, and their application to the useful aims of mankind. And we do ask, in addition, that he shall be actuated primarily by motives other than profit, which is the driving force appropriate to trade and commerce.

The degree conferred by a college upon a young graduate marks the faithful completion of a course of study; it does not in itself create an engineer. The license granted by a board of examiners establishes the experience and

[1] Westinghouse Electric Corp., Radio-Television Division, Metuchen, N. J.

[2] Dr. Julius A. Stratton, Vice-President and Provost of the Massachusetts Institute of Technology, Cambridge, Mass.

technical proficiency of the candidates, but he is not thereby invested with professional stature.

The Mark of a Profession

The mark of a profession is a way of life and it is achieved by the way of education. We live in the most complex society of all times and the demands that it makes upon men are infinitely diverse. There is no one plan of education best-suited to all needs, and the strength of our American system of education lies in the rich variety of its forms. There is an insatiable need by industry for engineers with sound practical training, and there should be schools in adequate number to supply them. There is a need too for young men prepared to rise to the most elevated ranks of their profession. It is my conviction that one and the same plan of engineering education cannot serve both the aims of immediate utility and the highest aspirations of the profession.

Engineering education is built upon mathematics and the physical sciences; with these must be fused the humanities as integral elements rather than peripheral—as the means to deepen the insight of the engineering student into the culture and problems of his society, and to create an awareness of his responsibilities and an understanding of the ethical principles upon which his decisions must rest. In this sense all subjects are professional, whether English or political economy, circuit analysis, or fluid mechanics, for all contribute to the making of a professional man. And in the hands of wise and gifted teachers, all these are liberal subjects, for each in its own way may open and free the mind.

ASME Project for Steam-Properties Research to Extend Present Tables to 1500 F and 15,000 Psia

A brochure, which describes a project for steam-properties research to provide data for the extension of the present tables to 1500 F and 15,000 psia, has been prepared by the ASME Research Committee on Properties of Steam and is available on request. It contains also a reprint of the article "The Present Status of Steam Properties," by Frederick G. Keyes and Joseph H. Keenan which appeared in Mechanical Engineering for February, 1955.

"Employment of very high pressures and temperatures," the brochure states, "is now common not only in the field of steam-power generation, including applications to atomic power, but also in the wide field of chemical processing. Designers are presently confronted with a variety of tables extrapolated to these higher limits from the experimental data on which the 1934 skeleton table was based."

At Philadelphia, Pa., in September, 1954, an international steam-tables conference was held with representatives of Canada, France, Germany, India, Italy, Japan, and the United Kingdom. At that conference The American Society of Mechanical Engineers was invited to serve as the secretariat for continued international co-operation in this work. It revived its own activities in this field in October of 1953 and has since appointed a Technical Committee on Properties of Steam under the chairmanship of P. H. Knowlton of Schenectady, N. Y., and an Administrative Research Committee on Properties of Steam of which J. W. Parker of Detroit, Mich., is chairman.

The research program proposed by the Technical Committee is to be fitted into an international framework and is stated as follows:

"1 To organize and direct systematic investigation and to promote international co-operation leading to the establishment of an extended International Skeleton Table which may be expected to receive international acceptance as complete as did the skeleton table of 1934.

"2 To report continually through presentation of papers before the Society and annually by reports to Council all results of experimental effort.

"3 To encourage critical analysis and formulation of experimental data by every means for the purpose of insuring thermodynamic consistency and ready use of the factual material.

"4 And, finally, to produce an ASME steam table extending to 1500 F and 15,000 psia based on the data of 1934 together with the results of a critical examination of all new experimental results which become available in any form prior to the completion of the proposed program.

"The project contemplates a considerable program of investigation in a number of American colleges under experienced leaders, and a most important part to be undertaken, quite properly, by the National Bureau of Standards in the establishment of new temperature standards and an acceptable set of conversion factors between the international temperature scale and the true thermodynamic scale.

Advantage will be taken, moreover, of authentic work that is under way or may be undertaken in other countries. The greater part of the investigations, other than the work done in other countries, will be that performed in the laboratories of several engineering colleges and universities in this country.'

Southern California Industrial Research Center Planned

Appropriately in this year of 1955, which marks the 75th birthday of the University of Southern California and the golden anniversary of its first engineering courses, plans are under way for the establishment on campus of a $1,000,000 Southern California Industrial Research Center.

Ground was broken late this fall for the first of four building units which will comprise an extension to the present School of Engineering building. Three of the initial units are designed to accommodate mechanical and aeronautical engineering, electronics and electrical engineering, chemical and petroleum engineering. The fourth will serve as a headquarters unit. In the future, additional classrooms, a library, and an alumni wing will be constructed.

Today, in addition to its regular basic research program, SC is handling 311 sponsored research programs for industry and government agencies, totaling more than $2.5 million.

Numbering among its members many leading industrial concerns in Southern California, SCIRC will receive an essentially unrestricted financial support from participating private corporations—a support that will help maintain the high level of the University's diversified educational program.

The University believes that the principal value of SCIRC affiliation to member companies will be the convenience of access to the activities of the Research Center and the fullest representation of their interests in exploring unusual problems.

Three new members, at $50,000 for a three-year period, have just been announced. They are Hoffman Radio Corporation, the Fluor Corporation, Ltd., and Union Oil Company of California.

On announcing their companies' interest in SCIRC, Reese H. Taylor, president of the Union Oil Company of California, and H. Leslie Hoffman, president of Hoffman Radio Corporation, stated, "The terrific shortage of engineers all over the country could become acute unless countermeasures are taken. Closer co-operation like this between universities and industries on the scientific level is vitally needed."

The progress of the University of Southern California has been simultaneous with that of the area it serves. As a privately financed and controlled university, it has always been free to respond to the community's needs.

Much of the success of the SC School of Engineering can be attributed to the personal attention given each student. It is the philosophy of the faculty that a personal relationship between teacher and student is essential to the study of engineering. Therefore every effort is made to keep classes small: No more than 35 in class lectures, 20 in laboratory sections.

The School's thorough training in fundamentals, its insistence upon a balance between theory and practice, and its intensive studies of industrial problems peculiar to the Southern California area also add to its popularity with leading Southland firms.

Approximately 500 graduate engineers are turned out each year toward the need for qualified personnel in this expanding industrial area. Graduate study is also made available to engineers who wish to improve their general qualifications and for engineering graduates who wish to pursue specialized research.

ASME Standards Workshop . . .

Interpretation of Code for Pressure Piping

From time to time certain actions of the Sectional Committee B31 will be published for the information of interested parties. While these do not constitute formal revision of the Code, they may be utilized in specifications, or otherwise, as representing the considered opinion of the Committee.

Pending revision of the Code for Pressure Piping, ASA B31.1-1955, the Sectional Committee has recommended that ASME, as sponsor, publish selected interpretations so that industry may take immediate advantage of corresponding proposed revisions. The following cases are published herewith as interim actions of Sectional Committee B31 on the Code for Pressure Piping that will not constitute a part of the Code until formal action has been taken by the ASME and by the American Standards Association on a revision of the Code.

Case No. 18

Inquiry: Is it permissible to use mechanical joints in cast-iron piping covered by Section 3 on Refinery Piping Systems of the Code for Pressure Piping?

Reply: It is the opinion of the Committee that mechanical joints in accordance with American Standard A21.11 Specifications for a Mechanical Joint for Cast-Iron Pressure Pipe and Fittings and the standards of the Cast-Iron Pipe Research Association covering cast-iron mechanical joints may be used in cast-iron piping covered by Section 3 until such time as the Code is revised accordingly.

Case No. 19

Inquiry: Is it permissible to use cast-iron pressure pipe in accordance with ASTM A377 Specification for Cast-Iron Pressure Pipe for cast-iron piping covered by Section 3 on Refinery Piping Systems of the Code for Pressure Piping?

Reply: It is the opinion of the Committee that in view of the cancellation of ASTM Specification A44 that cast-iron pipe in accordance with ASTM A377 Specification for Cast-Iron Pressure Pipe may be used in cast-iron piping by Section 3 until such time as the Code is revised accordingly.

The applicable American Standards as stipulated by A377 are:

A21.2 Cast-Iron Pit-Cast Pipe for Water or Other Liquids

A21.3 Cast-Iron Pit-Cast Pipe for Gas

A21.4 Cement-Mortar Lining for Cast-Iron Pipe and Fittings

A21.6 Cast-Iron Pipe Centrifugally Cast in Metal Molds for Water or Other Liquids

A21.7 Cast-Iron Pipe Centrifugally Cast in Metal Molds for Gas

A21.8 Cast-Iron Pipe Centrifugally Cast in Sand-Lined Molds for Water and Other Liquids

A21.9 Cast-Iron Pipe Centrifugally Cast in Sand-Lined Molds for Gas.

Case No. 20

Inquiry: May electric-fusion-welded austenitic stainless-steel pipe conforming to ASTM Specification A358 Electric-Fusion-Welded Austenitic Chromium-Nickel Alloy Steel Pipe for High-Temperature Service be used under Section 3 on Refinery Piping Systems of the Code for Pressure Piping?

Reply: It is the opinion of the Committee that electric-fusion-welded austenitic stainless-steel pipe complying with the requirements of ASTM Specification A358 may be used provided requirements are met:

(*a*) The joint efficiency shall be 85 per cent for material supplied in accordance with the specification.

(*b*) The joint efficiency shall be 100 per cent for piping in which the longitudinal welds are 100 per cent radiographed.

(*c*) The heat-treatment shall be a matter of agreement between the purchaser and the vendor based on the intended service.

(*d*) Stresses shall conform to A312 with the appropriate joint-efficiency factor.

(*e*) Radiographed in conformance with requirements of Par. 635(*b*)(2).

Case No. 21

Inquiry: May seamless steel pipe having 70,000 psi minimum tensile strength be used in the construction of piping under the rules of Section 1 of this Code?

Reply: It is the opinion of the Committee that carbon-steel seamless pipe having 70,000 psi minimum tensile strength may be used for Code construction under Section 1. The pipe shall be manufactured in compliance with the requirements of ASTM Specification A106 Seamless Carbon-Steel Pipe for High-Temperature Service with the following modifications:

(*a*) The carbon content shall not exceed 0.32 per cent by ladle analysis or 0.35 per cent by check analysis. Other chemical elements shall be as listed for A106 Grade B.

(*b*) The physical properties shall meet the following minimum requirements:

Tensile strength, psi	70,000
Yield point, psi	40,000
Elongation in 2 in. in the longitudinal direction of a standard round 2-in. gage length	20% min.

(*c*) The flattening test shall be as required for A106 Grade B.

(*d*) The grade designation for marking shall be "70,000 T.S. A106 Grade C."

(*e*) The maximum allowable stresses are:

−20 to 650 F. . .17,500 psi
700 F. . .16,600 psi
750 F. . .14,750 psi
800 F. . .12,000 psi.

Actions of the ASME Executive Committee at a Meeting at Headquarters, Sept. 22, 1955

A meeting of the Executive Committee of the Council was held in the rooms of the Society on Sept. 22, 1955. David W. R. Morgan, chairman, presided. In addition to Mr. Morgan, there were present: Frank L. Bradley, Thompson Chandler, A. C. Pasini, and Willis F. Thompson of the Executive Committee; Joseph L. Kopf, treasurer; E. J. Kates assistant treasurer; L. N. Rowley, Jr., chairman, Finance Committee; J. W. Barker, chairman, Organization Committee; William H. Byrne, vice-president; R. B. Lea, Joseph Pope, and H. C. R. Carlson, directors; C. E. Davies, secretary; O. B. Schier, 2nd, T. A. Marshall, Jr., and D. C. A. Bosworth, assistant secretaries; and Ernest Hartford, consultant.

Dues of Members in Foreign Countries

The Executive Committee voted that for other countries than Mexico, the following policy regarding payment of dues of members in foreign countries, as approved on Nov. 25, 1945, be extended for another year:

1 That the Society adopt a policy requiring all dues to be paid in United States dollars;

2 If such payment becomes excessive, upon request the Society may put the foreign member on suspended-dues list without service from the Society until such time as the Society may require him to pay his dues;

3 The young foreign student engineer who is in this country for one year may be permitted to pay the dues of a Student Member in order to have the privilege of receiving Mechanical Engineering and attending meetings during his residence in the United States.

Applied Mechanics Reviews

A contract with Southwest Research Institute was authorized to Dec. 31, 1956, for the preparation of material for *Applied Mechanics Reviews*.

The following increase in subscription rates was authorized:

$25 to any subscriber (formerly $12.50)
$20 to booksellers and libraries (formerly $10)
$10 to ASME members (formerly $9)
$7.50 to reviewers (formerly $5)

Approval was voted of a contract with the Office of Naval Research to provide $7500 for *Applied Mechanics Reviews* for the calendar year 1955.

ASME National Meetings

The following national meetings of the Society were authorized: 1956 Fall Meeting at Denver, Colo., Sept. 10-12 and 1957 Semi-Annual Meeting at San Francisco, Calif., June 9-12.

Conference on Fatigue

It was voted to authorize the co-operation of the ASME Applied Mechanics Division with The Institution of Mechanical Engineers of Great Britain on a Conference on Fatigue to be held in London, England, Sept. 10-14, 1956.

Conference on Lubrication and Wear

It was voted to accept the invitation of The Institution of Mechanical Engineers and authorize participation in a Conference on Lubrication and Wear to be held in London, England, Oct. 1-3, 1957.

New Division

The establishment of a Lubrication Division of the Society was authorized.

1956 Calvin W. Rice Lecturer

Designation of D. F. Galloway as Calvin W. Rice Lecturer at the Semi-Annual Meeting, Cleveland, Ohio, June 17-21, 1956, was approved.

Topic for Charles T. Main Award

"The Modern High-School Program as a Preparation for Engineering Education" was approved as the Charles T. Main Award Topic for 1956.

1955 Awards

The following awards were approved for 1955:

Blackall Machine Tool and Gage Award to C. J. Oxford, Jr., and J. A. Cook for their paper on "The Influence of Tap-Drill Size and Length of Engagement Upon the Strength of Tapped Holes"

Charles T. Main Award to Richard J. Slember for his paper on "The Atom and the Mechanical Engineer"

Undergraduate Student Award to Nino R. Addonizio for his paper on "Analysis of Vibration Isolation for Vaneaxial Fans to Reduce Shipboard Noise"

Letter-ballot approval was confirmed of the following awards recommended by the Board on Honors at its meeting on June 20, 1955:

Junior Award to Ferdinand Freudenstein, Assoc. Mem. ASME, for his paper "Approximate Synthesis of Four-Bar Linkages"

Melville Medal to Robert Talbot Knapp, Mem. ASME, for his paper "Recent Investigations of the Mechanics of Cavitation and Cavitation Damage"

Prime Movers Committee Award to Louis Elliott, Fellow ASME; Walter Frederic Friend, Mem. ASME; Edward Charles Duffy, Mem. ASME; G. A. Gaffert (deceased); Fred William Argue, Mem. ASME; and B. G. A. Skrotzki, Mem. ASME, for their contribution to the "ASME Symposium on the Design and Operation of Outdoor Power Plants"

Spirit of St. Louis Junior Award to John Burton Nichols, Assoc. Mem. ASME, for his paper "An Energy Basis for Comparison of Performance of Combustion"

Richards Memorial Award to Sylvan Cromer "for outstanding achievement in mechanical engineering within 20 to 25 years after graduation"

Pi Tau Sigma Gold Medal Award to Robert Charles Dean, Jr., Assoc. Mem. ASME, "for outstanding achievement in mechanical engineering within 10 years after graduation."

Professional Practice of Consulting Engineering

The Secretary presented a statement from the Committee on Professional Practice of Consulting Engineering, dated June 22, 1955, pointing out that both this Society and the American Society of Civil Engineers have committees devoted to promoting the standards, development and utility of, and interest in, the Practice of Consulting Engineering "to the end that it may serve commercial and industrial enterprises and public needs more effectively and efficiently."

At a meeting of representatives of ASME, ASCE, and the American Institute of Consulting Engineers on March 22, 1955, there was discussion of how best to develop over-all co-ordination, co-operation, and guidance for engineers in consulting practice. Creation of an Engineers Joint Council standing committee on Professional Consulting Engineering Practice was suggested.

The Executive Committee voted to suggest to EJC that it establish such a standing committee for the review of current standards, development and utility, manuals, practices, and the like, and recommend co-ordinated procedures for the conduct of professional consulting-engineering practice.

75th Anniversary Medal

A special 75th Anniversary Medal and Certificate was voted to Thorndike Saville in recognition and appreciation of his leadership as president of Engineers Joint Council.

Research Agreement

A co-operative agreement with the Bureau of Mines relating to research activities of the Research Committee on Furnace Performance Factors was approved by this research committee on April 21, 1955. This covers the computation of flame temperatures and correlation of performance data and is a continuation of the committee's former research program at the Bureau of Mines.

The agreement covers the period July 1, 1955, to March 31, 1956, inclusive.

Regional Meeting

Vice-President W. F. Thompson reported that it is proposed to hold a New England Regional Meeting in Norwich, Conn., Oct. 19, 1956, with technical sessions sponsored by some Professional Divisions.

Annual Meeting

It was voted to request J. W. Barker, chairman of the Organization Committee, to make a presentation on Aims and Objectives of the Society at the usual Sunday evening discussion meeting this year, to be held on Nov. 13, at Chicago, before representatives of the Boards, Professional Divisions, and technical committees.

Certificates of Award

Certificates of Award were approved for Fred E. Lyford for his past services on the Admissions (1939-1945) and Finance Committees (1944-1949).

Certificates of award were granted to the following retiring members of the Nominating Committee: E. W. Allardt, chairman; Roy C. Robertson, secretary; Bertram G. Dick; Guerard Mackay, Philip C. Osterman, Lauren E. Seeley, Richard B. Stewart, and J. G. Van-Vleet.

The following retiring chairmen of Sections were granted certificates of award: Henry A. Naylor, Jr., Baltimore; John F. Mummert, Birmingham; Andrew H. Hines, Jr., Florida; David P. Tellett, Minnesota; Frank C. Kuska, Nebraska; Max Watson, New Orleans; Robert W. Cox, North Texas; Robert Wiegand, Oregon; Ralph R. Smith, Toledo; and W. H. Kreamer, Virginia.

New Engineering Societies Building

In connection with the selection of a site for the new engineering societies building, the five presidents recommended on July 25, 1955, that a Task Committee be appointed composed of three representatives from each of the five societies. The Executive Committee voted to appoint E. G. Bailey, James W. Parker, and James M. Todd to serve as ASME representatives on the Task Committee which is charged with "the duty of recommending a specific site for the Engineering Societies Center, based upon a review and comprehensive additional study of feasible locations."

Gift to Society

At a previous meeting the President reported that a gift of money had been received from Mrs. Walter C. Baker of Cleveland, the widow of an ASME member. Vice-President Chandler was asked to consider possible useful disposition of this gift. On his recommendation it was voted to transfer the gift to the Cleveland Section for administration.

Arthur L. Williston Award

An additional contribution for the Arthur L. Williston Award was received June 16, 1955, from the donor, Arthur L. Williston.

Reciprocal Initiation Fees

It was voted to make effective on Oct. 1,

1955, the reciprocal arrangement with The Engineering Institute of Canada on initiation fees. This arrangement was approved by the ASME on June 19, 1955, and by EIC on July 29, 1955. (See MECHANICAL ENGINEERING, August, 1955, p. 752.)

Report to ECPD

The formal annual report of ASME representatives on Engineers' Council for Professional Development for presentation at the ECPD Annual Meeting, October 13–14, was approved.

EUSEC Copenhagen Meeting

President Morgan reported on the EUSEC meeting in Copenhagen, Denmark, Sept. 5–9, 1955. See report on pages 1016 to 1018 of this issue.

Honorary Membership was bestowed on Georg F. C. Dithmer, president of EUSEC, on September 6. Seventy-Fifth Anniversary Medals were bestowed on the societies participating in EUSEC and on the secretaries of the EUSEC societies. The ASME film "To Enrich Mankind" was shown.

The Executive Committee voted to extend the appreciation of the Society to Ambassador Robert Coe and to his staff for their splendid co-operation in the ceremonies at the American Embassy in Copenhagen.

1958 EUSEC Meeting

President Morgan reported that EUSEC has accepted the invitation of the U. S. Delegation to hold the next meeting in the United States during the first three weeks of April, 1958.

Verein Deutscher Ingenieure

The Secretary reported a communication from the Verein Deutscher Ingenieure advising that it will celebrate its 100th anniversary May 12–15, 1956, and would be pleased "if your Society would honor us with their presence at our celebration." It was voted to designate representatives of the Society to participate in the centennial celebration of the Verein Deutscher Ingenieure in May, 1956.

Hoover Medal Fund

The Secretary reported that the Hoover Medal Fund has received an anonymous gift of $5000. The total amount of the fund is thereby increased to nearly $18,000.

He also reported that the 1955 Hoover Medal has been bestowed on Charles F. Kettering. Formal presentation will be made during the Annual Meeting of the Society in Chicago, November, 1955.

Ernest F. Mercier

The Committee noted with regret the death on July 11, 1955, of Ernest F. Mercier who was elected to ASME Honorary Membership in March, 1955.

C. E. Gorton

The death on Aug. 20, 1955, of C. E. Gorton who served as Manager of the Society, 1925–1928 and as Vice-President, 1928–1930, was also noted with regret.

Appointments

The Committee approved appointments on Boards, Committees, and Joint Activities recommended by the Organization Committee at its meeting on Sept. 21, 1955. (ASME Annual, AC-10, "Personnel of Council, Boards, and Committees" to be issued early in 1956, will contain these appointments.)

Presidential Representatives

The following appointments of presidential representatives were noted:

H. R. Kessler, G. J. Nicastro, and C. B. Peck as Tellers on Election of Officers;

D. C. Neithercut to Dedication of United States Air Force Academy, Denver, Colo., July 11, 1955;

Carl F. Kayan to Ninth International Congress of Refrigeration, Aug. 15–Sept. 15, 1955;

R. S. Hartenberg to Verein Deutscher Ingenieure, Mechanisms Conference, Germany, Oct. 1, 1955.

Engineering Societies Personnel Service, Inc.

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York 8 West 40th St.	Chicago 84 East Randolph St.	Detroit 100 Farnsworth Ave.	San Francisco 57 Post St.

Men Available[1]

Industrial Engineer, ME, 31, married; candidate MS(IE) Columbia. Seven years' industrial experience. Desires position with administrative opportunities in the control functions: Production, inventory, quality or budgetary; or in economic engineering. Commuting distance of New York City. Me-252.

Administrative and Mechanical Engineer, BME, 27, married; $3^1/_2$ years' diverse experience in production engineering and manufacturing. Desires position with progressive firm offering opportunity for management responsibility. Terminate Army service February, 1956. Location, open. Me-265.

Mechanical Engineer, 32, BS, MS, registered, married, children. Will relocate. Two years' design of steam turbines; five years' design of wide range of centrifugal and rotary pumps. Seeks executive position in related field. Extensive knowledge of manufacturing processes including foundry and heat-treating. Much customer contact. Me-266.

Mechanical Engineer, 45, desires executive position responsible to top management as liaison between engineering and sales. Twenty-three years' work experience includes application, product development and analysis, sales, technical instruction formulation, supervisory installation, design, liaison engineering of industrial instrumentation and processing machinery marketed to chemical, paper, textile, lumber, ceramic, steel, petroleum, and shipbuilding industries; also government agencies, at management level. Consulting experience. Direct contacts with consulting engineers and research laboratories. Will relocate. Me-267.

Project Engineer, 30, single, BSME, M.I.T.; MS(ME), Minnesota; MBA, Rutgers, six years' varied experience in electromechanical field involving design, development, and project engineering, as well as, administrative and supervisory work. Desires position with broader responsibilities. Prefers northern N. J., but will relocate. Me-268.

[1] All men listed hold some form of ASME membership.

Positions Available

Professor, mechanical graduate, teaching experience in general mechanical engineering, including applied thermodynamics and machine design. Near East. W-2138(*b*).

Engineers. (*a*) Application engineers, air conditioning and refrigeration, graduates, three to five years' experience in survey, load calculations, equipment selection, installation supervision. Various locations in U. S. (*b*) Development engineers for product development of mechanical equipment in air-conditioning and refrigeration fields. Experience in rotating equipment; or appliances; or heat-transfer equipment. $5500–$7000. Upstate N. Y. W-2143.

Digital Computer Engineer, mechanical graduate, familiar with design, operation, and engineering problems of high-speed rotating machinery, to engage in analysis of design parameters in preparation for computer programming and reduce engineering problems to terms that can be used by the computer. $6500–$7500. Mass. W-2161.

Production and Plant Engineer, 28–43, mechanical-engineering training and at least five years' supervisory experience covering metal stampings, screw-machine products, and assembly work. $7000–$10,000. Ontario, Can. W-2164.

Engineers. (*a*) Co-ordinator of management development, 33–43, MS or doctorate degree with major in fields of industrial psychology, industrial education, business administration. Six to ten years' experience in fields of management appraisal and development, personnel research, management training, recruitment, etc. Will perform duties in connection with corporation-management inventory and development program. Salary open. (*b*) Statistical quality-control engineer, 25–40, degree in statistical

quality control, some industrial experience in the application of statistical quality control in metals industry preferred. Familiar with control charting techniques, statistical sampling plans for inspection, and use of multiple correlation techniques in planning and analysis of experimental data. Salary open. Calif. W-2167.

Product Designer, mechanical graduate, about ten years' experience in design of instruments or mechanisms of a quality nature, including knowledge of sheet-metal construction, to prepare schematic drawings and layouts of new equipment from verbal instruction and rough descriptions, supervise work of detailers and supply-shop co-ordination. $7800–$9360. N. Y. metropolitan area. W-2170.

Sales Engineer, about 45, mechanical graduate, at least ten years' sales experience calling on manufacturers of industrial machinery selling small pumps, hydraulic equipment, bearings, and machinery for territorial supervisory duties. $12,000–$15,000. N. J. metropolitan area. W-2178.

Chief Plant Industrial Engineer, 35–45, industrial or mechanical graduate, ten years' experience covering the application of labor standards for standard cost and supervisory control purposes. Will take charge of operating supervision, union representatives, and staff personnel at policy-making level on all matters pertaining to labor standards and their application. State salary required. Va. W-2184.

Production Manager, mechanical engineer, extensive production-management experience, preferably in plastic extrusion and fabrication. $10,000, with stock option. Md. W-2186.

Facilities Engineer, 30–40, mechanical graduate, project and plant-engineering experience covering planning, specifications, layout, and installation of water lines, heating systems, and general building maintenance in process manufacturing plant. $8000–$9200. N. J. W-2188.

Engineers. (*a*) Methods engineer, industrial or mechanical degree, preferably with knowledge of stampings and/or roll-forming processes in the automotive field. Opportunity for junior engineer to join staff of medium-sized multiplant operation. $4800–$5400. Ohio. (*b*) Tool engineer, light stampings and roll-forming operations. Liaison, trouble shooting, toolroom supervision. $7200. Ky. W-2196.

Assistant Design Engineer, preferably with mechanical degree, training in basic stress analysis, strength of materials, and mechanics. Experience with strain-gage measurements and indicators desirable. Will assist in the design of pressure vessels, particularly in accordance with ASME Pressure Vessel Code. Will perform stress analysis of existing vessels and perform development work toward improvement of pressure vessels and their accessories. Salary open. Company will pay fee. Northern Ohio. W-2198.

Engineers. (*a*) Design engineer, mechanical graduate, experience covering design of high-vacuum pumps for exhausting electronic tubes and general laboratory use. $6000–$7500. (*b*) Research engineer, mechanical graduate, at least ten years' research, development, and design experience covering pneumatic and hydraulic valves and pumps. $8000–$10,000. Mass. W-2201.

Estimating Engineer, mechanical graduate, at least ten years' design, estimating, and production experience covering electronic components and radio accessories. $8000–$10,000. Westchester County, N. Y. W-2206.

Senior Machine Designer, 35–45, mechanical graduate, at least five years' supervisory experience in machine-design field, including packaging machinery. $8000–$10,000. Boston, Mass. W-2229.

Assistant Maintenance Superintendent, mechanical or electrical degree preferred, minimum of five years' experience in supervision of mechanical and electrical maintenance work, to assist supervision of all maintenance work in mine, mill, sinter plant, and village of large northeastern N. Y. mining operation. $6000–$7500, plus salary benefits. W-2236.

Engineers. (*a*) Senior project engineer to direct the design and development of hydraulic pumps, motors, and related equipment for aircraft application. Mechanical engineer, broad design experience in the aircraft hydraulic equipment field. $10,000–$12,000. (*b*) Senior design engineers, to design and develop hydraulic pumps, motors, and related equipment for aircraft application. Mechanical engineer with appropriate design experience. $6000–$9000. Upstate N. Y. W-2246.

Industrial Engineer, 32–42, IE or BA degree, background in management consulting and ten years' industrial experience, particularly in procedures, cost analysis, standards, etc. $8000–$10,000. Reasonable amount of travel. Ohio. W-2253.

Industrial Engineers for foreign assignment. (*a*) Production planning engineer, experience in electronic and electromechanical fields. $12,000–$15,000. Holland. (*b*) Industrial engineer, preventive maintenance experience in manufacturing industries. $12,000–$15,000. Italy. (*c*) Industrial engineer, 30–40, preventive maintenance experience in rubber, chemical, or process industry. $10,000–$12,000. Two-year contract. Italy. F-2263.

Engineers. (*a*) Staff industrial engineer, to head up complete projects for large firm of industrial-management consultants. $8500–$10,000. (*b*) Industrial engineer, considerable background and experience in the installation of wage-incentive plans, preferably with diversified industrial application. $7200–$8500. Pa. W-2267.

Machine Designer and Plant Designer for process equipment—plant piping, etc. Company manufactures synthetic fibres and transparent films (cellophane). $6240–$7280. New York, N. Y. W-2271.

Engineers. (*a*) Production engineer to head up materials handling and shipping for large multiplant container operation. Some traveling between plants. $10,000–$12,000. (*b*) Production engineer, to head up section of company devoted to coatings. Experience in lithography and lacquering and other coating materials as used in container industry. $10,000–$12,000. New York, N. Y. W-2273.

Chief Engineer, mechanical or electrical graduate, at least ten years' experience covering design and production of insulated-wire products. $12,000–$15,000. N. Y. metropolitan area. W-2277.

Administrative Engineer, up to 45, mechanical graduate, at least ten years' experience in administrative work. Duties of an administrative nature. Position offers unusual opportunity to an engineer who is a capable administrator and an effective supervisor, for manufacturer of industrial tractor equipment. $10,000. Employer will pay fee. Ill. C-3792.

Chief Engineer, Equipment Division, to 45, mechanical graduate, at least five years' experience in product design and management engineering. Knowledge of pressure-rotating equipment, control apparatus, and compressed gases. Will manage and direct equipment-development department. Complete charge of development, product design, and production engineering for manufacturer of pressure-regulating equipment and flow-control apparatus. $9000–$11,000. Employer will negotiate placement fee. Mo. C-3798.

Manufacturing Executive, mechanical, 44–48, five years' experience in fabrication of food, dairy, or liquid machinery as plant manager or works manager. Knowledge of fabricated light-gage stainless steel. Responsible for manufacturing light machinery and equipment for food, dairy, or bottling industries. $12,000–$14,000. Employer will negotiate fee. Iowa. C-3823.

Plant Engineer, 35–45, two years' experience supervising plant engineering and maintenance work. Knowledge of electrical and mechanical equipment. Supervise crew of 50 to 60 people doing maintenance work covering all trades, welding, machine shop, steam generators, and power distribution for manufacturer of auto accessories. Up to $9000. Employer will negotiate placement fee. Ind. C-3922.

Supervisor Test Engineers, 32–50, mechanical, electrical, or aeronautical, three years' experience in development or testing of heat exchangers or aircraft components. Will supervise exacting test work in laboratory on aircraft components, equipment, and accessories. One man as chief test engineer and two as assistants for manufacturer of auto equipment. Up to $9600. Employer will negotiate fee. Ind. C-3923.

Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after Nov. 25, 1955, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any Member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately

New Applications

For Member, Associate Member, or Affiliate

Adams, David G., Omaha, Neb.
Adams, Farrell W., Monroe, La.
Aiken, Hector H., Los Gatos, Calif.
Aldred, John L., Glenview, Ill.
Altman, Manfred, Scotia, N. Y.
Anderson, Donald R., Downers Grove, Ill.
Anderson, John O., Detroit, Mich.
Antoszewski, Walter J., Toledo, Ohio
Armitage, Walter H., Rome, N. Y.
Ashworth, Ralph S., Jr., Brooklyn, N. Y.
Attenhofer, Max W., Erie, Pa.
Balazs, Alexander W., Milwaukee, Wis.
Ballantyne, Robert P., Detroit, Mich.
Banner, Leslie T., Montreal, Que., Can.
Barns, Lewis W., Ceres, N. Y.
Bauernfeind, Norman G., Racine, Wis.
Billingsley, John G. S., Northfield, Vt.
Black, Robert J., Holyoke, Mass.
Boatman, Harold R., Chicago, Ill.
Boosinger, Thomas H., Kansas City, Kan.
Brandau, Frederick L., Chicago, Ill.
Brown, John M., Andover, Mass.
Browne, Robert J., Detroit, Mich.
Brush, Donald A., Webster, N. Y.
Campbell, John F., Monongahela, Pa.
Chen, Chia-Tseng, New York, N. Y.
Clarke, John S., Burnley, Lancashire, England
Combs, Raymond E., New York, N. Y.
Cotten, Soule E., Wilmington, Del.
Curran, Francis J., Olean, N. Y.
Deuster, Ralph W., New York, N. Y.
Dixon, Charles P., Mexico, D. F., Mex.
Dubois, John P., Englewood, Colo.
Elmer, S. Lewis, Jr., St. Louis, Mo.
Ericksen, Herbert A., Skokie, Ill.
Fernando, Stanley E., Colombo, Ceylon
Ffrench, Leopold A., Mexico, D. F., Mex.
Flesher, David L., Chicago, Ill.
Frank, Arnold W., Forest Hills, N. Y.
Franks, Roger G. E., Philadelphia, Pa.
Freeman, Harry, Providence, R. I.
Gabloffsky, Heinz, Chicago, Ill.
Gatewood, Buford E., Dayton, Ohio
Gorman, Arnold A., Toronto, Ont., Can.
Green, Glenn W., Toledo, Ohio
Greiner, Frank M., Jr., Ypsilanti, Mich
Grove, Victor A., Titusville, N. J.
Handelman, George H., Troy, N. Y.
Happel, Anton W., Indianapolis, Ind.
Havemann, Hans A., Bangalore, S. India
Hoehl, Frank B., Wheeling, W. Va.
Hopkins, Stephen, Beacon, N. Y.
Hopper, Edwin T., Beloit, Wis.
Huff, Howard W. L., Chicago, Ill.
Jackson, Rex L., Akron, Ohio
Jackson, Wilbur W., College Park, Md.
Jung, Robert C., Columbus, Ohio
Kee, Norman L., New York, N. Y.
Kemper, John D., Van Nuys, Calif.
Kidle, George W., Ligonier, Pa.
Kolm, Harvard B., Jr., Minneapolis, Minn.
Leinen, Robert E., Lake Jackson, Texas
Lidford, John A., Wellsville, N. Y.
Lippincott, Wallace S., Baltimore, Md.
Ludwig, Lawrence P., Racine, Wis.
Lutz, Stephen A., Dearborn, Mich.
McCormick, Francis A., Toledo, Ohio
Monks, William R., Ellwood City, Pa.
Morton, James E., Pensacola, Fla.
Moseley, Marvin J., Jr., Harriman, Tenn.
Muehl, Wallace W., Manila, P. I.
Musick, Victor S., Schenectady, N. Y.
Newton, Eugene H., Jr., Royal Oak, Mich.
Novosad, Thomas L., Bellaire, Texas
O'Connell, Jackson E., Elmhurst, Ill.
Onnen, John E., Chicago, Ill.
Palafox-Trujillo, Carlos, Mexico, D. F., Mex.
Pastore, Michael W., West Simsbury, Conn.
Phelps, Thomas W., La Crescent, Minn.
Pigford, Thomas H., Cambridge, Mass.
Porter, James A., Pontiac, Mich.
Rauch, Dale H., Dearborn, Mich.
Reza, Syed H., Champaign, Ill.
Rollings, Robert C., Sr., Augusta, Ga.
Rosenthal, Harold, Levittown, Pa.
Russell, Herbert E., Akron, Ohio
Saenz, Alfonso M., Jacksonville, Fla.
Salerno, Vito L., New York, N. Y.
Savino, Joseph M., Cleveland, Ohio
Schwartz, Clarence C., Lake Jackson, Texas
Shaffer, William R., Huntingdon, Pa.
Shutie, Alan L., Karachi, W. Pakistan
Spallarossa, Mario J. L. M., Buenos Aires Argentina
Sundholm, Olaf A., Bayside, N. Y.
Taylor, Robert N., 3rd, Philadelphia, Pa.
Tennimon, Oakland A., Decatur, Ala.
Terrell, B. J., Midland, Texas
Tetlow, George L., Chicago, Ill.
Tillung, Kenneth O., Beloit, Wis.
Turker, Turhan, Istanbul, Turkey
Underwood, Robert D., Harrison, N. Y.

VANQUAETHOVEN, F. F., Forest, Belgium
VARGO, E. JAMES, Cleveland, Ohio
VERNIE, JACOBUS E., West New York, N. J.
VOELLINGER, ROBERT J., East St. Louis, Ill.
VOSE, FREDERIC H. E., San Francisco, Calif.
WHITE, ROGER T., Mexico, D. F., Mex.
WHITFIELD, CARROLL J., Pensacola, Fla.
WICKSTROM, GEORGE, SR., Roselle, Ill.
WILLIS, ALAN E., Stamford, Conn.
WITT, ZOLLIE L. W., Knoxville, Tenn.
WOODALL, JAMES F., San Francisco, Calif.
WOOTON, JOHN, JR., Detroit, Mich.
YANUS, GEORGE A., Chalmette, La.
ZAVERUHA, VICTOR A., Trumbull, Conn.

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ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

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Address of employer .... ☐
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Product or service of company ....

Title of position held ....

Nature of work done ....

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☐ MECHANICAL ENGINEERING	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

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☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ S—Power
☐ C—Management	☐ L—Process Industries	☐ T—Textile
☐ D—Materials Handling	☐ M—Production Engineering	☐ V—Gas Turbine Power
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ W—Wood Industries
☐ F—Fuels	☐ O—Lubrication	☐ Y—Rubber and Plastics
☐ G—Safety	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ H—Hydraulics	☐ Q—Nuclear Engineering	

Change in Grading

Transfer to Member or Affiliate

BIRKNESS, HARALD A., Whiting, Ind.
BOWKER, JOHN E., Gales Ferry, Conn.
BRAUN, ROBERT H., San Mateo, Calif.
BUXTON, WILBERT J., Scarsdale, N. Y.
BYERLEY, WILBUR M., Philadelphia, Pa.
DOHNA, ALFRED E., Groton, Conn.
EFT, NEIL W., Alliance, Ohio
EISENSTADT, RAYMOND, Schenectady, N. Y.
FARBER, ERICH A., Gainesville, Fla.
FLEISCHAUER, FRED J., Pittsburgh, Pa.
FRENCH, ROBERT F., Moline, Ill.
GRAHAM, ROBERT W., Cleveland, Ohio
HILLER, JOHN D., San Francisco, Calif.
KREISLE, LEONARDT F., Austin, Texas
LARSEN, DONALD H., Stamford, Conn.
LYERLY, RAY L., Buffalo, N. Y.
LYNN, NORMAN, Inglewood, Calif.
MANGAN, WILLIAM E., South Charleston, W. Va.
NOREEN, ALFRED E., Cincinnati, Ohio
PARKER, JOHN, Kingston, R. I.
PICKFORD, ALLAN E., Arcadia, Calif.
PONTIUS, PAUL E., Erie, Pa.
ROOSMAN, ROBERT Q., Silver Spring, Md.
ROTH, IRWIN S., New York, N. Y.
SCOVILL, ROGER P., Madison, Wis.
SMITH, CLYDE W., Orchard Park, N. Y.
WHITE, GARLAND B., JR., Elizabethtown, Ky.
WOOD, ORLA L., JR., Schenectady, N. Y.

Transfers from Student Member to Associate Member 41

Obituaries . . .

Robert Sherwood Anderson (1928–1955?), who was employed in the stress-analysis department, Chance Vought Aircraft, Inc., Dallas, Texas, died according to information received by the Society. Born, Tulsa, Okla., March 20, 1928. Education, BS(ME), Oklahoma A&M College, 1950. Assoc. Mem. ASME, 1950.

Hardage Lane Andrews (1889–1955), retired, executive vice-president, Industrial Products and Lamp Group, General Electric Co.; president, Jones & Lamson Machine Co., Springfield, Vt., died Aug. 4, 1955, at his home in Bridgeport, Conn. Born, Boonville, Mo., Oct. 25, 1889. Parents, Edward and Jennie (Dobyns) Andrews. Education, BS(EE), University of Missouri, 1910. Married Mittie Stephens Huff, 1917; children, Hardage L., Jr., John H. Mem. ASME, 1954. Author of many technical papers which were presented before various professional societies.

Robert Earl Armstrong (1912–1955), mechanical-design engineer, Office Engineering Division, Metropolitan Water District of Southern California, Los Angeles, Calif., died July 18, 1955. Born, Lomita, Calif., Jan. 20, 1912. Parents, Charles T. and Blanche E. Armstrong. Education, BS, University of California at Berkeley, 1935. Assoc. Mem. ASME, 1935. Married Omah I. Johnson, 1936; children, Kirk R., Joan I.

Oliver D. H. Bentley (1877–1954), consulting engineer, Strawberry Hill, Dover, Mass., died May 20, 1954. Born, Providence, R. I., July 6, 1877. Parents, Jetson W. and Ellen L. Bentley. Education, public schools, Providence, R. I.; private instruction. Married Dorothy Beebe, 1917; children, John E., Effie E., Dorothy E., Howard B., Carolyn R. Mem. ASME, 1910. He held approximately 50 patents relating to steam turbines.

Ames Bliss (1918–1955), chief engineer, Forge and Ordnance Division, Cameron Iron Works, Inc., Houston, Texas, died May 26, 1955. Born, Chicago, Ill., Sept. 4, 1918. Education, BS(EE), Massachusetts Institute of Technology, 1939. Mem. ASME, 1954. Survived by wife.

Sidney E. Borgeson (1896–1955), consulting engineer, Kaiser Aluminum Co. of Newark, Ohio, died Aug. 2, 1955, in Hahnemann Hospital, Philadelphia, Pa. Born, Atwater, Minn., Feb. 22, 1896. Education, BA(Physics), University of Minnesota, 1922; postgraduate work in physics, 1923. Mem. ASME, 1946. He held many patents related to wire machinery and coil-winding machinery. Survived by wife, Mrs. Florence Wilson Borgeson; a daughter; two brothers; and four sisters.